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USER'S MANUAL FOR GENERALIZED ILSGLD-ILS
GLIDE SLOPE PERFORMANCE PREDICTION:
MULTIPATH SCATTERING

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16. Abstract This manual presents the computer program package for the generalized ILSGLD scattering model. The text includes a complete description of the program itself as well as a brief description of the ILS system and antenna patterns. The program listings are included as appendixes, and contain both input-generation programs and output-plotting programs.		
For a technical mathematical analysis of the system see the FAA report, "ILS Glide Slope Performance Prediction: Multipath Scattering."		
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PREFACE

This document is a companion document to the Federal Aviation Administration report, "ILS Glide Slope Performance Prediction: Multipath Scattering," and contains the computer program for applying the model developed in the aforementioned report. The computational program may be used to predict the performance of new ILS glide slope systems, or modified existing systems. The manual contains a complete description of the glide slope system, the program listings, and step-by-step instructions for running the computer program.

METRIC CONVERSION FACTORS

Approximate Conversion from Metric Measures			
What You Know	Measure by	To Find	
		<u>AREA</u>	
millimeters	0.001		
centimeters	0.04		
meters	0.03		
kilometers	0.001		
		<u>MASS (weight)</u>	
milligrams	0.001		
grams	0.02		
kilograms	0.001		
		<u>VOLUME</u>	
milliliters	0.001		
liters	0.02		
hectoliters	0.001		
cubic millimeters	0.001		
cubic centimeters	0.001		
cubic meters	0.001		
		<u>TEMPERATURE (heat)</u>	
Celsius	5/9 (from add 32)	Fahrenheit	
temperature		temperature	



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1. INTRODUCTION: DEFINITION OF INSTRUMENT LANDING SYSTEM

In a previous report,* a computer program (ILSGLD) was written to simulate certain terrain conditions which affect the glide slope portion of the Instrument Landing System (ILS). The ILSGLD model was developed to treat one-dimensional terrain variations. This report describes a generalized version of ILSGLD which treats two-dimensional ground plane variations, and which is able also to simulate the effects of scattering from planar, randomly oriented rectangular surfaces. A technical mathematical analysis of the system is described in a separate report.**

The ILS is used to provide signals for the safe navigation of landing aircraft during periods of low cloud cover and other conditions of restricted visual range. Separate systems are used to communicate vertical and horizontal information; the vertical system is called the "glide slope." This system operates by the transmission of an RF carrier, amplitude modulated by two audio frequencies, and beamed to approaching airborne receivers. In an instrumented aircraft, the glide slope receiver serves to demodulate the RF signal, amplify and isolate the corresponding audio signals and derive a signal to drive the ILS vertical display in the cockpit. The pilot, by reading the display, can determine if he is on course, above or below the glide path. These signals must be strong enough to cover a radius of 15 miles in front of the antenna.

* "ILS Glide Slope Performance Prediction," FAA RD 74-157B, Part II. 9/74.

** FAA, ILS Glide Slope Performance Prediction: Multipath Scattering, In Preparation.

The directional information is determined by the relative strengths of the transmitted sideband signals. The audio frequency modulations, which are fixed at 90 and 150 Hz, are radiated in different angular patterns with respect to the intended glidepath. The "course" is defined as the locus of points where the amplitudes of the two modulations are equal. The display of a difference of the amplitudes (90 and 150 Hz) of the sidebands is referred to as the Course Deviation Indication. Thus, the CDI is the pilot's indication as to what his deviation is relative to the glidepath. The CDI is measured in microamperes. The actual course generated by any particular ILS installation will deviate from the ideal because of irregularities in the terrain. The deviation of the CDI caused by these irregularities, from the ideal receiver reading at that point in space (e.g., on the glidepath a CDI reading other than 0) is the derogation effect.

The glide slope system transmits an asymmetrical pattern by beaming a "carrier plus sideband" pattern and a "sideband only" pattern, the composite of which gives the desired effect.

2. ANTENNA PATTERNS

The proper angular variation of the transmitted 90 and 150 Hz modulation is achieved by the radiation of the two independent sideband patterns by the transmitting antenna. One pattern, the "carrier plus sideband" (C+S) signal, is radiated in a symmetrical pattern; the other pattern, the "sideband-only" (SO) signal, is radiated in an "anti-symmetrical" pattern relative to the prescribed glide angle (see Figure 1).

The C+S signal is composed of a carrier wave and paired sideband waves at 90 and 150 Hz. The sideband amplitudes are equal and represent a 40 percent modulation of the carrier wave (or a "depth of modulation" of 0.4) at both frequencies. The SO wave is a carrier wave that is equally modulated at 90 and 150 Hz to the extent that it retains no pure carrier component.

The spatial modulation pattern obtained by combining the symmetrical C+S pattern with the "anti-symmetrical" SO pattern is illustrated in Figure 1. At a given receiver point the total signal is the C+S carrier plus the combined sideband amplitudes of the C+S and SO patterns. The sideband amplitudes are phased so that above the glide path the 90 Hz amplitudes add and the 150 Hz amplitudes subtract, while below the glide path, the 90 Hz amplitudes subtract and the 150 Hz amplitudes add.

Any angular deviation of the airplane's receiver from the correct course results in a "Difference in Depth of Modulation" (DDM) between the 150 and 90 Hz signals. Since the strength of C+S and SO signals fall off at the same rate with distance from the transmitting antenna, the DDM is independent of range.

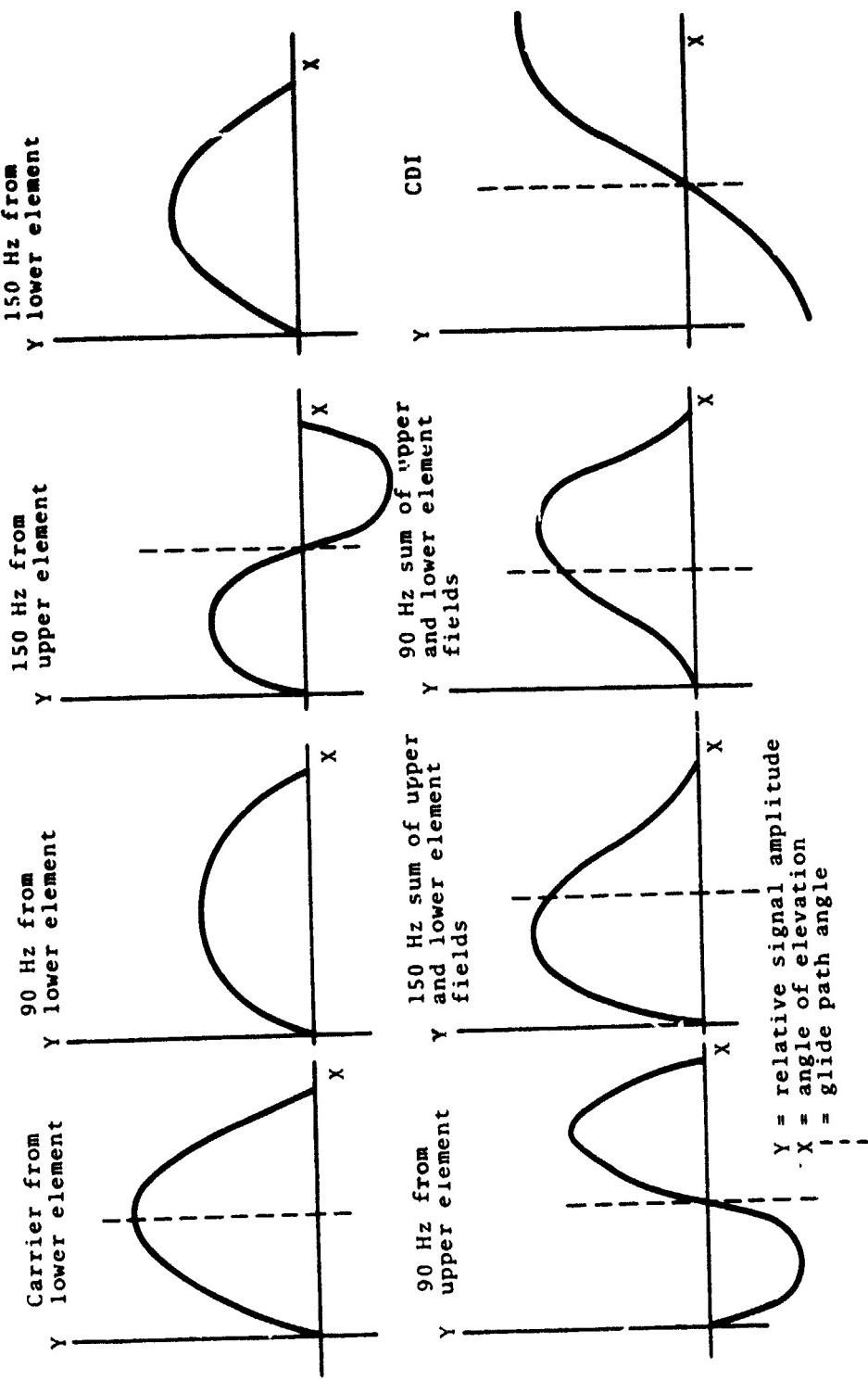


FIGURE 1. ANTENNA PATTERNS FOR NULL REFERENCE ANTENNA

The antenna patterns are generated by using arrays of one or more elements in combination with the ground as reflector. The effect of an ideal ground plane on a single element is as though there was an "image" element located below the ground and radiating equal power to the real element but with opposite phase. In a glide slope array there will be two or more elements radiating different signals to give the desired combined antenna pattern. (Note that this means that a glide slope array is defined by giving, for each element, its location and complex amplitude of the carrier and sidebands.) However, the real ground is not an ideal plane. This has the effect of distorting the element patterns and results in a derogation of the glide slope system performance.

The extended glideslope derogation simulation package consists of five programs. They are:

- FMAKE.F4 Used to generate input files for the simulation.
- ILSVEN.F4 Simulates the one-dimensional-variation ground. Takes input prepared by FMAKE. Outputs the complex field intensities at the various receiver locations.
- MOLE.F4 Simulates the scattering from a rectangular planar surface with arbitrary orientation. Takes as input the data output from ILSVEN. Outputs a new set of fields.
- GLDCDI.F4 Simulates the effects of the receiver, including CDI determination and dynamic smoothing from the instrumentation.
- GLDPLT.F4 Produces graphical presentations of the CDI results from the simulation. Takes as input the data file

output from GLDCDI. Outputs graphs of various forms as determined by the user.

The inputs and operation of these programs will be given in the following sections.

The basic procedure is to prepare the input with FMAKE. The ground effects are determined by running ILSVEN. The output is a data file containing the antenna descriptors, the receiver locations and the complex field intensities for the carrier and sidebands. If desired GLDCDI may be run at this point to produce the CDI's that would be produced by this round configuration, antenna system, and flight path. If additional scatterers are involved such as buildings or hills, they may be represented as rectangular surfaces and the derogation effects added with MOLE. MOLE may be used as often as needed to include any number of scattering surfaces. After all surfaces have been included GLDCDI is run to generate the CDI file for input to the graphing program. GLDPLT is then run to generate the graphs required.

3. GROUND EFFECT SIMULATION WITH ILSVEN

The ILSVEN program simulates the effects of a non-planar ground on the glide slope antenna system.

The program uses a ground description, an antenna description and a set of spatial coordinates for the receiver locations as input. The program calculates the outputs for each receiver location, the complex values of the fields for carrier and sidebands that would be received at that location. This represents the summation of the direct fields from each antenna element and the fields from each antenna element scattered from the parts of the ground "plane." Additionally the fields that would be produced by an ideal ground plane are included. This allows comparison with flights that do not have a simple ideal CDI along the flight path, for example, flights at right angles to the glide path such as are used to determine the course width.

The ILSVEN simulation makes certain simplifying assumptions. They include:

- a. Perfectly reflecting ground surface
- b. Far-field scattering--all scattering from points on the ground surface is assumed independent of all other points; thus multiple reflections and near-field interactions are ignored
- c. Noise-free environment
- d. Relative field strengths--the absolute field strengths involved are not calculated. Thus, while the CDI's can be calculated in microamperes, the absolute electric field intensities are not ascertained,

e. Geometric shadowing--the shadowing of one portion of the ground on another is done by straight ray approximations assuming a total cutoff with no diffraction, and

f. Antenna elements are assumed to be simple dipoles.

3.1 METHOD OF SIMULATION

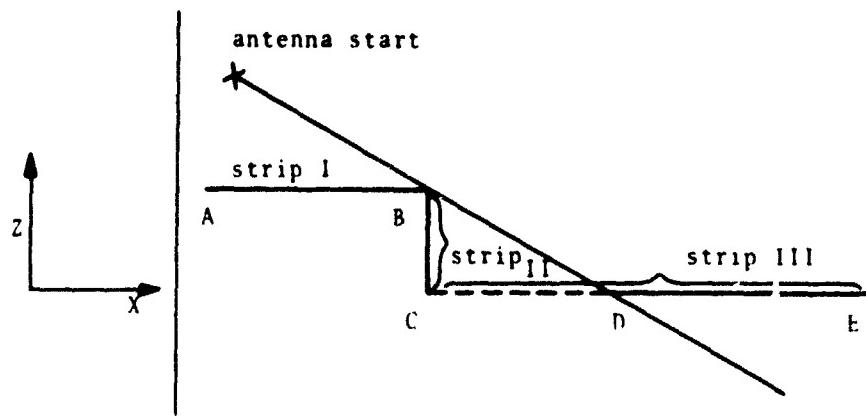
An antenna element is described by giving its x , y- and z-coordinates and the complex amplitudes of its radiated amplitude at the three frequencies (carrier, 150 and 90 Hz sidebands). The ground is broken up into strips; these strips have an infinite width and a finite length. The infinite extent is parallel to the y-axis, that is at a right angle to the runway centerline. Thus, a ground strip is described by giving the x and z-coordinates of the leading and trailing edges of the strip. A receiver location is described by giving its time, x-, y- and z-coordinates.

The basic part of the simulation consists of calculating the field at a receiver location. This field is caused by the power radiated from an element and reflected from a strip. The receiver field can be expressed as a complex gain factor times the radiated antenna field. This gain factor is expressed as a double integral over the strip. The integration along the infinite extent (y axis direction) was approximated by using the stationary phase method. The resulting single integral is solved by a modified trapezoid rule. The trapezoid rule is used with the spacing between sample points adjusted for the derivative of the integrand.

Thus, for a given receiver location, the program takes an antenna element and calculates the "gain factor" for each ground strip, multiplies by the radiated power. and sums the three complex

field intensities for all ground strips. The direct field of the element at the receiver is then added. This process is repeated for all elements, giving the total field at the receiver. For comparison purposes the fields resulting from an ideal ground plane are calculated. The location of the receiver (x -, y -, z - and t coordinates) are output along with the six complex field intensity numbers. This is then repeated for each receiver location in the input file.

If the terrain is sufficiently irregular, part of the energy radiated toward a point on the ground may be intercepted by another piece of the ground closer to the antenna. This shadowing is complex including, as it does, diffraction as well as reflection. This is approximated in the simulation by using ray optics; that is, the shadow is assumed to have no diffraction at the edges and a zero field amplitude inside of the shadow. The program does this by assuming the ground is continuous; i.e., the far edge of one strip is the near edge of the next, and keeping track of the "furthest" (in angular sense) edge. If part (or all) of the next strip is "below" that edge, then that part (or all) will not be included in the trapezoid integration. For example in the sketch below:



all of strip I, none of strip II and that part of strip III between D and E will be included in the integration.

For the receiver antenna a "semi" directional antenna is assumed; that is, only the incident fields from the front half-sphere around the receiver are included. This is as though an omni-directional antenna was used but blocked by the fuselage from receiving signals from the direction of the tail. This is done in the program by stopping the summation of fields over the ground strips at a point directly below the receiver.

The back half-plane is assumed to be an ideal flat horizontal reflector of infinite extent. The field from this is included by adding the "gain factor" for this as an initial strip to that calculated by integrating over the "real" strips.

3.2 OPERATION

ILSVEN assumes the ground description is a file called GRND.DAT, and that the receiver locations are in a file called PATH.DAT. The user starts the program and then inputs the name of the file containing the antenna description. The simulation will be run, and the output will be found in file STRIP.DAT.

4. ADDITION OF SCATTERERS WITH MOLE

MOLE is used to include the derogation effects of finite scatterers. This would include sides of buildings and other man-made objects composed of flat rectangular surfaces. In addition portions of the ground surface such as hills can be simulated if they may be represented by rectangular pieces. The program takes as input a file generated by ILSVEN. This contains the antenna and flight path descriptions along with the complex fields scattered from the ground for both the non-planar ground simulated and for the ideal ground case. The program adds to these fields the fields resulting from scattering from the piece being simulated and outputs a new data file containing the input data with revised values for the complex fields. The output file being in the same format as the input file allows this output to be used as the input for another run of the MOLE program. This permits the user to continue to add in the effects of as many scatterers as desired.

The simulation makes certain simplifying assumptions. They include those explained for ILSVEN. In addition, the ground surface for the MOLE simulation is assumed to be the ideal flat horizontal ground plane. Thus the multiple reflections from the antenna element to ground to scatterer, and from scatterer to ground to receiver, are done using a simple ground plane.

To operate the program the user will have previously run ILSVEN to simulate the terrain involved. When MOLE is run, the program will request:

INPUT FILE NAME:

The user types in the name of the file output from ILSVEN. This is initially named STRIP.DAT, but may have been renamed by the user if there is more than one simulation to be done.

The program will then request:

OUTPUT FILE NAME:

The user then types in the name to be given to the file to be output from MOLE. This file will contain the modified filed values in addition to the antenna and flight path data from the input.

The program will then read in the piece description data from unit 20. (Normally, it is a disk file FOR20.DAT.) These data are in free-field general FORTRAN format (3G). The data consist of the x-, y-, and z-coordinates for the four corners of the rectangle, one set of coordinates per line. The corners are described in the order that they would be scanned in traveling around the perimeter of the rectangle in a clockwise direction. In this sense, the rectangle is assumed to be facing the user. For example, the coordinates:

0.0.0,

1.0.0,

1.0.1, and

0.0.1,

describe a square, one foot on a side, situated on the centerline of the runway oriented with one side on the centerline on the ground, and one side vertical at the origin. The "front" of the square is facing in the positive y-direction. See figure example (Figure 2).

The program will then execute the simulation, output the new file, and terminate. Multiple runs, scatterers and input cases may be set up using the usual batch control features.

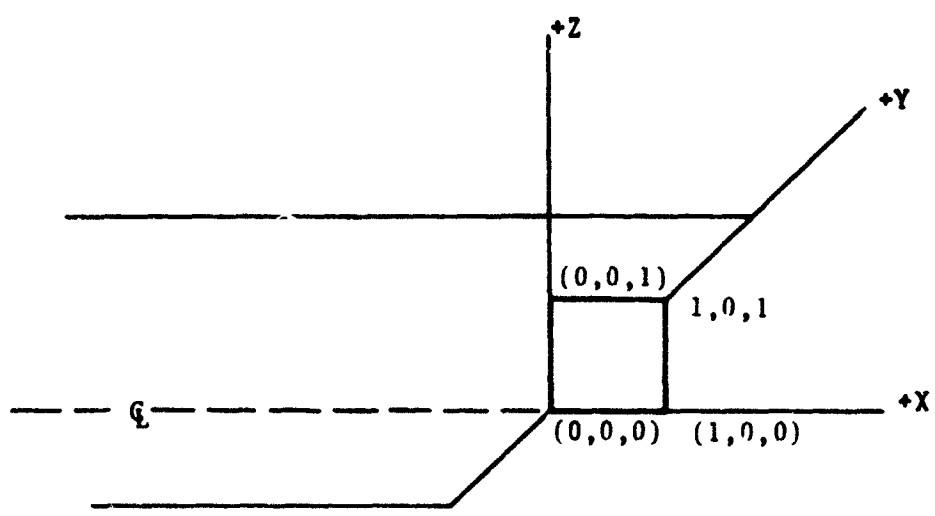


FIGURE 2. REPRESENTATION OF SQUARE SCATTERER

5. CDI DETERMINATION USING GLDCDI

The output files from ILSVEN and MOLE contain the complex field intensities for the carrier and sidebands for the cases simulated. For analysis purposes the user would usually wish to see the CDI's produced. The difference between these and the correct CDI's is the derogation that would affect the pilot in the case being studied. This CDI generation is done by GLDCDI. The program will calculate the CDI for both the static case and for a dynamic case using the smoothing time constant input in FMAKE.

To operate the program the user runs GLDCDI. The program will request:

INPUT FILE NAME:

The user then types in the name of the file (generated by ILSVEN or MOLE). The program will then request:

OUTPUT FILE NAME:

The user then types in the name of the file to be used for the output file. The program will then execute and terminate. The output file contains the CDI's static and dynamic for both the simulation and the ideal ground case. The various CDI's may be graphic using GLDPLT.

6. FMAKE PROGRAM DESCRIPTION

FMAKE is a file generation program used to create input files for ILSVEN. It is designed to be used interactively. The user starts by running the program. The program will respond by typing:

INPUT SWITCH:

The user then types in a single character switch, followed by a <CR>, for the file he wishes to generate. The program will then respond with a request for the input required for that file. If a blank is used as the input switch the program will terminate. If any character other than those explained below are used, an error message will be given. After each file is generated, the program will return to the switch input point thus allowing the user to generate the data files for many simulation runs in one sitting.

(N.B. All units are in feet unless otherwise stated)

6.1 SWITCH: Y

For this switch (Y), the program will type:

INPUT YO, LAMBDA:

The user then inputs in free field format the y-offset (i.e., the y-coordinate) of the antenna elements and the wavelength of the carrier, followed by a <CR>. The y-offset is the distance from the base of the antenna to the centerline of the runway. As this information is required for both the antenna description and the flight path, it is input with a separate switch to avoid repetition.

6.2 SWITCH: G

This switch (G) is used to input the ground description.

The program will respond with:

INPUT GROUND FILE NAME:

The user then inputs a <five(5) character name for the ground description file, followed by a <CR>. ILSGLD requires the ground file to be called GRND.DAT. (The .DAT extension is a system default.) FMAKE allows the user to generate several ground files with different names at one sitting. Then by using system renaming commands, a single batch job may be set up that will run many simulations without further user interactions.

The program will then type:

INPUT GROUND LABEL.

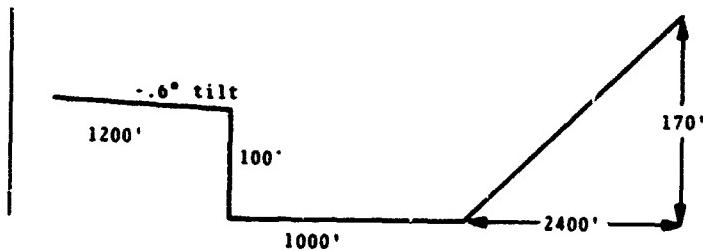
The user then inputs up to 40 characters to be used as a label for this ground description. The label is carried in the ground description file and will be placed in the output file by ILSGLD. It allows the GLDPLOT program to label the plots with the ground description. This is necessary if a batch job generates plots from more than one simulation.

The program will then type:

INPUT GROUND SEGMENTS. STARTING FROM ANTENNA GIVE CONSECUTIVELY EITHER X AND Z INCREMENTS OR THE LENGTH AND ANGLE FROM HORIZONTAL IN DEGREES, SEPARATED BY A ZERO. HIT CARRIAGE RETURN FOR END OF DATA, OR IF THERE ARE NO MORE STRIPS.

The user inputs ground strip end points in either Cartesian or polar increments using two or three fields respectively. They are input in floating free field format followed by a <CR>. The first point is taken relative to the origin and is the near edge of the closest strip to the antenna. The second point is the far edge of the first strip and the near edge of the second strip.

This second point is relative to the first. This will continue for additional strips until a <CR> is hit with no data, at which point the program will return to the switch input. For example to input this profile:



The input would be

0.,0.

1200., 0., -.6

0., -100.

2400., 170.

There is a maximum of 20 strips allowed in both FMAKE and ILSGLD. This is determined by array sizes and could be changed if desired.

6.3 SWITCH: P

This is used to generate a flight path file. The program will respond:

INPUT FLIGHT PATH FILE NAME:

The user then inputs a five (5) character file name (the name must be exactly 5 characters). ILSGLD requires the flight path to be in

a file called PATH.DAT (for explanation of multiple files see SWITCH:G). The program will then type:

INPUT FLIGHT PATH TITLE:

The user then inputs a title, using up to 40 characters, for the flight path. This is used as a label on the plots output by GLDPLT. The program will then type:

INPUT FLIGHT PATH TYPE:

The user has a choice of two flight path types, linear or hyperbolic. For a linear flight path, type a <CR>; for a hyperbolic path type a 'G' followed by a <CR>. When it is a linear flight the program will respond:

INPUT X0, Y0, Z0:

The user then inputs the x-, y-, and z-coordinates of the first receiver point in free field floating point format followed by a <CR>. The program will respond:

INPUT XF, YF, ZF:

The user then inputs the final receiver location in the same way. The program then types:

INPUT # OF POINTS, VELOCITY, TIME CONSTANT:

The user then inputs the total number of receiver locations desired in integer free field format, followed by the velocity of the aircraft in feet/sec. in floating point free field and the time constant in seconds (usually 0.4) used for the "inertia" of the receiver in dynamic simulation. The program will then generate the data file and return to the SWITCH POINT.

The actual ideal surface of zero CDI is a hyperboloid of two sheets whose axis of rotation is parallel to the z-axis and passes through the antenna. For comparison purposes it is convenient to

have the aircraft travel along this surface and see how the real CDI deviated from 0. If the glide path is used for linear flight in the near field (between threshold and antenna) large CDI's will occur because of the hyperbolic shape. The program will allow the user to generate a hyperbola which is the intersection of the 0 CDI surface and the plane containing the runway centerline parallel to the z-axis. To do this the user types a 'G' for the flight path type. The program will respond:

INPUT XO, XF, H:

The user inputs these in floating point free field format followed by a <CR>. XO is the x-coordinate of the initial receiver point (YO is zero and ZO is specified by the hyperboloid), XF is the x-coordinate of the final receiver point. H is the height of the main carrier element in the antenna array. The program will then respond:

INPUT # OF POINTS, VELOCITY, TIME CONSTANT

These are input as above. The program will generate the file and return to the switch point.

6.4 SWITCH: A

This switch is used to generate the antenna description file.

The program will respond:

INPUT ANTENNA FILE NAME:

The user inputs the 5 character file name. The program will type:

INPUT ANTENNA DESCRIPTION:

The user inputs a <40 character antenna description to be used as a plot label. The program will then type:

INPUT ELEMENT VALUES:

The user then types in, in free field floating format, a maximum of 8 fields followed by a <CR>. The fields have the following use:

<u>field #</u>	<u>use</u>
1	x-coordinate of element (usually 0)
2	z-coordinate of element (height)
3	real amplitude of carrier
4	imaginary amplitude of carrier
5	real amplitude of 150 Hz side band
6	imaginary amplitude of 150 Hz side band
7	real amplitude of 90 Hz side band
8	imaginary amplitude of 90 Hz side band

This element inputting is repeated for each element. After the last element is input an extra carriage return is typed. No y-coordinate is input for the elements. This is because nominally all the elements have the same y offset (the value input as Y0 under switch:Y). However, a small offset correction is applied for near field correction. An explanation of this correction may be found in part I (see discussion preceeding Eq. (33)). This is automatically done by the program. As the first element input is assumed to have the correct offset, it will always have a value of Y0. Thus the main carrier element should be input first, for example, a null reference antenna was input as follows:

INPUT SWITCH: Y

INPUT Y0, LAMBDA: 300., 3.

7. GLDPLT PROGRAM DESCRIPTION

GLDPLT is a plotting output program to graph the CDI information from GLDCDI. The user runs GLDPLT which then types:

INPUT FILE NAME AND AXIS TYPE:

The user then types in a 5 character (left-justified and blank filled to 5 characters) and two integer fields in free field format. The first integer is the switch for x-axis type and the second integer is the switch for the y-axis. The y-switch has two values, 1 and 2, the x-switch has three 1, 2, and 3; any other values will terminate the program.

The switches have the following use:

y-switch=1 this plots the static CDI values

y-switch=2 this plots the dynamic CDI values

x switch=1 this uses the altitude angle, in degrees measured from the origin of the receiver point as x-coordinate

x-switch=2 this uses the x-coordinate of the receiver as the x-axis

x-switch=3 uses the time in seconds, at the receiver point, as the x-coordinate.

After the input, a plot is generated and the program returns to the input and asks for the data for the next plot. The user can give the same file name to plot the data differently, or a new file name can be given. This would be done when multiple runs were done before plotting, the output file from each simulation run carrying its own name.

INPUT SWITCH: A

INPUT ANTENNA FILE NAME: NULL

INPUT ANTENNA DESCRIPTION

NUL REFERENCE ANTENNA

INPUT ELEMENT VALUES

0., 15., 1., 0., .4, 0., .4, 0.

0., 30., 0., 0., -.12. 0., .12, 0.

APPENDIX A ILSVEN

ILRVEN.F4

F4B

V27(36B)

22-APR-78

13184

```

1      DIMENSION ILABL(8)
2      DIMENSION IPTDAT(33)
3      COMMON /PLKT/ NRP,RXH4,RXMX,RXFT,RXL,T,RVMN,RVNX,RVFT,RVLT,
4      1R2MN,R2MX,R2FT,R2LT,RTMN,RTHX,RTFT,RTLT,
5      2AIMN,AIMX,AIFT,AILT,ARMN,ARMX,ARFT,ARLT,
6      3ADIN,ADIN,ADIF,ADIL
7      4ADRn,ADRn,ADRF,ADRL
8      EQUIVALENCE (IPTDAT(1),NRP)
9      IMPLICIT COMPLEX (C)
10     DIMENSION X(20),Y(20),Z(20)
11     DIMENSION CF1(20),CF2(20),CF3(20)
12     IMPLICIT DOUBLE PRECISION (D)
13     COMMON /RECRX/RX,RZ,RT,NSIZE
14     REAL LAMBDA
15     COMMON /GROUND/ K,X1(20),Z1(20),X2(0/20),Z2(0/20),IEL
16     COMMON /ANT/AK,AY,AZ,LAMBDA,DAK,DPI
17     COMMON /VAL/ MR,MI
18
19     C      THIS VALUE OF TWO PI IS INITIALIZED THIS WAY TO AVOID USING
20     C BLOCK DATA
21     DP1=6.2831853071795864769
22
23     C      THIS OPENS THE OUTPUT FILE
24     CALL OFILE(1,'STRIP')
25
26     C      THIS SUBROUTINE OPENS THE FLIGHT PATH FILE AND RETURNS WITH
27     C THE FLIGHT PATH PLOT LABEL (ILABL) AND TIME CONSTANT (TAU)
28     C THE FILE WAS SET UP WITH JOURNAK SO THIS SUBROUTINE AND INPUT ARE
29     C USED TO FACILITATE MODIFICATIONS
30     CALL IP(ILABL,TAU)
31     1000 FORMAT(8A9,F1)
32     WRITE(1,1000) ILABL,TAU
33
34     C      THIS SECTION INITIALIZES SOME CONSTANTS
35     NRP=0
36
37     C      THIS SECTION INPUTS THE GROUND STRIPS DESCRIPTIONS
38     CALL IFILE(20,'GRND')
39     READ(20,1000) ILABL
40     WRITE(1,1000) ILABL
41     READ(20) K,X1,Z1,X2,Z2
42     CALL RELEASE(20)
43
44     C      THIS SECTION INPUTS THE ANTENNA FILE NAME TO BE USED
45     C AND THEN INPUTS THE ANTENNA ELEMENT DESCRIPTIONS
46     WRITE(9,2001)
47     2001 FORMAT(' INPUT ANTENNA FILE NAME:',S)
48     READ(9,2002) ILBL
49     2002 FORMAT(A9)
50     CALL IFILE(20,ILBL)
51     READ(20,1000) ILABL
52     WRITE(1,1000) ILABL
53     READ(20) LAMBDA,NEL,(X(I),Y(I),Z(I),CF1(I),CF2(I),CF3(I),I=1,NEL)

```

118EN.F6

F48

V27(368)

22-APR-73

11184

```
94      WRITF(1) LAMBDA,NEL,(X(1),Y(1),Z(1),CF1(1),CF2(1),CF3(1),ID1,NEL)
95      CALL RELEAS (26)
96      SORT2L=1./SORT(2.,LAMBDA)
97      TEMP=LAMBDA
98      DAK=DPI/DOLE(LAMBDA)
99      SAK=ENGLIDAK)

100     C
101     C      THIS IS THE MAIN LOOP FOR THE SIMULATION.  THE RECEIVER
102     C LOCATION IS READ IN BY INPUT.  THE DATA IS IN COMMON 'REC'
103     C THE INPUT BEING DONE BY JOVRAX.  IF THERE ARE NO MORE RECEIVER
104     C POINTS THE SUBROUTINE RETURNS TO 200.
105     C      CALL INPUT(S20R)

106     C
107     C      THIS SECTION INITIALIZES THE COMPLEX AMPLITUDES FOR
108     C THE RECEIVED FIELD AS FOLLOWS:
109     C      CFR1  CARRIER WITH 'REAL' GROUND
110     C      CFR2  150 MZ SIDEBAND WITH 'REAL' GROUND
111     C      CFR3  90HZ SIDEBAND WITH 'REAL' GROUND
112     C      CFS1  CARRIER WITH 'IDEAL' FLAT GROUND PLANE
113     C      CFS2  150HZ WITH 'IDEAL' GROUND
114     C      CFS3  90 MZ WITH 'IDEAL' GROUND
115     C      CFR1=(F.,0.)
116     C      CFR2=(0.,0.)
117     C      CFR3=(0.,0.)
118     C      CFS1=(0.,0.)
119     C      CFS2=(0.,0.)
120     C      CFS3=(0.,0.)
121     C      R2=SQRT(RX*RX+RZ*RZ)

122     C
123     C      THIS LOOP IS OVER THE ELEMENTS OF THE ANTENNA
124     C THE COMPLEX FIELDS ARE SUMMED IN CFR1,CFR2 ETC.
125     C      DO 3 IEL=1,NEL
126
127     C
128     C      THESE ARE THE LOCATION COORDINATES OF THE ANTENNA ELEMENTS
129     C AND CONSTANTS USED IN THE STRIP INTEGRATION
130     C      AX=X(IEL)
131     C      AY=Y(IEL)
132     C      AZ=Z(IEL)
133     C      DELX=RX-AX
134     C      DELY=RY-AY
135     C      DELZ=RZ-AZ
136     C      DR=DSQRT(DELX*DELX+DELY*DELY+DELZ*DELZ)
137     C      R=SQNL(DR)
138     C      DR=D*DAK
139     C      IL=UR/DPI

140     C
141     C      THIS SECTION INITIALIZES MR AND MI TO INCLUDE THE
142     C SEMI-INFINITE REAR GROUND PLANE
143     C      TEMPDR=DR-DBLE(FLOAT(IL))*DPI
144     C      TEMPDR2=AZ
145     C      F1=SORT(TEMP+TEMP*AY*AY)
146     C      F2=-4X*TEMP/(R2*F1)
147     C      TC=SORT(1.+AY*AY/(TEMP*TEMP))
```

118EN,F4 F4B V27(36P) 22-APR-76 11:54

```

137      TD=TP0A2
138      R1=R2=TC
139      S=SDRT((1./R2+1./A2)/(TC+TC+TC)).
140      G=RX/(TD+TD+R1+R1+S)
141      TEMP0=SAK0F1
142      SF=SIN(TEMP)
143      FC=COS(TEMP)
144      TE4P0A2=G/DAK/F2
145
146      C      HR AND HI ARE THE REAL AND IMAGINARY PARTS OF THE COMPLEX
147      C 'GAIN' FACTOR OF THE GROUND SURFACE SCATTERING TO THE RECEIVER
148      C LOCATION
149      HR=TEMP0*(SF+FC/(DAK+TD))
150      HI=TEMP0*(FC-SF/(DAK+TD))
151
152      C      THIS SUBROUTINE SUMS THE 'GAIN' FACTOR FOR EACH STRIP OF
153      C THE GROUND SURFACE
154      CALL SCAT
155
156      C      THIS SECTION INCLUDES THE EFFECT OF THE DIRECT RADIATION FROM
157      C THE ANTENNA ELEMENT AT THE RECEIVER
158      HR=SH0SDRT2L
159      HI=H1*SDRT2L
160      TEMP0=ELV/(R0R)
161      SF=SIN(TEMP2)
162      FC=COS(TEMP2)
163
164      C      CTEMP IS THE COMPLEX GAIN FACTOR INCLUDING ALL RADIATION FROM
165      C THIS ELEMENT
166      CTTEMP=CMPLX(-TEMP0*SF+HR+HI,TEMP0*FC+HR+HI)*.5/LAMBDA
167
168      C      THIS SECTION ACCUMULATES THE FIELDS OF THE VARIOUS FREQUENCIES
169      CF$1=CF$1+CTEMP*CF1(IFL)
170      CF$2=CF$2+CTEMP*CF2(IFL)
171      CF$3=CF$3+CTEMP*CF3(IFL)
172      ALPH0=SAK2.*A2*RE/R
173      CTTEMP=TEMP*.5/LAMBDA*CMPLX(-SF,FC)*
174      1CMPLX((1.-COS(ALPH)), -SIN(ALPH))
175      CFR1=CFR1+CTEMP*CF1(IFL)
176      CFR2=CFR2+CTEMP*CF2(IFL)
177      CFR3=CFR3+CTEMP*CF3(IFL)
178      3  CONTINUE
179      WRITE(1,2003) RX,RV,RZ,RT,CFR1,CFR2,CFR3,CFS1,CFS2,CFS3
180      2003 FORMAT(4F/,/.6E13.6,/.6E13.6)
181      GO TO 201
182
183      C      THIS IS THE TERMINATION SECTION.  THE INITIAL RECORD ON
184      C THE OUTPUT FILE IS WRITTEN AND THE PROGRAM TERMINATES.
185      CALL RELEASE(1)
186      CALL EXIT
187      STOP
188      END
  
```


IL8EN.F9

F40

V27(36P)

22-APR-76

11:09

1 SUBROUTINE INPUT(S)
2 COMMON /REC/ RX(4),NSIZE
3 IF(NSIZE.LE.0) RETURN 1
4 CALL JOVNL1(S,RX,4,0)
5 NSIZE=NSIZE-1
6 RETURN
7 END

CONSTANTS

0 000000000001 1 000000000004 7 000070000000

COMMON

RX /REC /08 NSIZE /REC /04

SUBPROGRAMS

JOVNL1

SCALARS

INPUT 36 NSIZE 4

ARRAYS

RX 0

INPUT	1
JOVNL1	4
NSIZE	2
REC	2
RX	2
	4
	5

IL8VER.F4

F48 V27(368)

22-APR-70

11105

```
1      C
2      C THIS SUBROUTINE SUMS THE EFFECTS OF THE STRIPS THAT MAKE
3      C UP THE GROUNDSURFACE. THERE ARE 'N' STRIPS DESCRIBED IN COMMON
4      C GROUND AS FOLLOWS:
5      C      X1()  THE X-COORDINATE OF THE LEADING EDGE OF THE I'TH STRIP
6      C      Z1()  THE Z-COORDINATE OF THE LEADING EDGE OF THE I'TH STRIP
7      C      X2()  THE X-COORDINATE OF THE ENDING EDGE OF THE I'TH STRIP
8      C      Z2()  THE Z-COORDINATE OF THE ENDING EDGE OF THE I'TH STRIP
9      C
10     C SUBROUTINE SCAT
11     C COMMON /REC/ RX,RY,RZ
12     C COMMON /ANT/ AX,AY,AZ
13     C COMMON /GROUND/ R,X1(28),Z1(28),X2(28/22),Z2(28/22),IEL
14     C COMMON /SEG/ XX1,ZZ1,XX2,ZZ2,N
15
16     C THESE ARE INITIAL VALUES FOR THE PARAMETERS USED IN SHADOWING
17     C SLOPE=1.
18     C PHIE=1.
19
20     C THIS IS THE LOOP OVER THE STRIPS
21     C DO 1 101,K
22
23     C THESE ARE THE VALUES TO BE USED IN THE STRIP
24     C INTEGRATION SUBROUTINE
25     C      XX1  LEADING X-COORDINATE
26     C      ZZ1  LEADING Z-COORDINATE
27     C      XX2  TRAILING X-COORDINATE
28     C      ZZ2  TRAILING Z-COORDINATE
29
30     C      XX1=X1()
31     C      ZZ1=Z1()
32     C      XX2=X2()
33     C      ZZ2=Z2()
34
35     C THIS IS A TEST TO SEE IF THE SUMMATION OVER THE GROUND
36     C STRIPS HAS REACHED THE RECEIVER LOCATION. IF IT HAS THE SUMMATION
37     C IS STOPPED. THIS IS TO GIVE THE EFFECT OF FORWARD LOCKING RECEIVER
38     C ANTENNA PATTERN.
39     C      IF(XX1 .GE. RX) GO TO 6
40
41     C IF THE RECEIVER IS LOCATED OVER THE MIDDLE PORTION OF A STRIP
42     C THE STRIP WILL BE INTEGRATE ONLY UP TO THE VALUE OF THE
43     C RECEIVER X-COORDINATE
44     C      IF(XX2 .LE. RX) GO TO 5
45     C      ZZ2=Z2+(RX-XX1)*(ZZ2-ZZ1)/(XX2-XX1)
46     C      XX2=RX
47     C      CONTINUE
48
49     C THIS SECTION DOES THE SHADOWING. IF PART OR ALL OF THE STRIP
50     C IS IN THE SHADON OF A PREVIOUS STRIP, THIS STRIP WILL BE ELIMINATED
51     C OR MASKED TO GIVE THE EFFECT OF SHADOWING.
52     C      DELX=XX2-AX
53     C      IF(DFLX .LE. 0.) GO TO 3
54     C      PHIE=(AZ-ZZ2)/DELX
55     C      IF(SLOPE .LT. P.) GO TO 3
```


A	58	59	60				
ANT	11						
AX	11	52	55	59	60	61	
AY	11						
AZ	11	52	55	60	61		
B	59	62					
DELK	58	51	52				
GROUND	12						
I	28	28	29	30	31		
IEL	12						
K	12	28					
M	13						
PHID	55	56					
PHIE	17	52	54	67			
REC	18						
RX	18	37	42	43	44		
RY	18						
RZ	18						
SCAT	9						
SEG	13						
SLOPE	14	53	54	56	68	61	67
SUM	66						
X1	12	28					
X2	12	30					
XX1	13	28	37	43	55	57	58
XX2	13	38	42	43	44	58	57
Z1	12	29					
Z2	12	31					
ZZ1	13	29	43	55	58	59	61
ZZ2	13	31	43	52	58		
1P	28	54	68				
3P	51	53	56	66			
4P	57	61					
9P	42	45					
8P	37	69					

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```
1      C
2      C      THIS SUBROUTINE INTEGRATES OVER THE SURFACE STRIP DEFINED
3      C BY X1,X2,X2,E2 IN COMMON 'SEG', TO GIVE THE FIELD EFFECT
4      C OF THE ANTENNA ELEMENT IN COMMON 'ANT' AT RECEIVER DEFINED
5      C IN COMMON 'REC'.  THE VARIABLES ARE AS FOLLOWS:
6      C      AX   ANTENNA X-COORDINATE
7      C      AY   ANTENNA Y-COORDINATE
8      C      AZ   ANTENNA Z-COORDINATE
9      C      LAMBDA WAVELENGTH OF CARRIER
10     C      AK   TWO=PI/LAMBDA
11     C      DP1  TWO=PI (DOUBLE PRECISION)
12     C      RX   RECEIVER X-COORDINATE
13     C      RY   RECEIVER Y-COORDINATE
14     C      RZ   RECEIVER Z-COORDINATE
15     C      HR   REL PART OF 'GAIN' FACTOR
16     C      HI   IMAGINARY PART OF 'GAIN' FACTOR
17     C      X1   LEADING EDGE OF STRIP'S X-COORDINATE
18     C      Z1   LEADING Z-COORDINATE
19     C      X2   TRAILING EDGE X-COORDINATE
20     C      Z2   TRAILING Z-COORDINATE
21     C      THE INTEGRATION IS PERFORMED BY A MODIFIED TRAPEZOID RULE,
22     C      THE SPACING BETWEEN POINTS ALONG THE VARIABLE OF INTEGRATION
23     C      IS VARIED BY THE RATE OF CHANGE OF THE INTEGRAND,
24      C      SUBROUTINE SUM
25      C      COMMON /SEG/ X1,Z1,X2,Z2,N
26      C      DOUBLE PRECISION A1,A2,B1,B2,XL,AY2
27      C      REAL    JR,JI,J0R,J0I,JNR,JNI
28      C      REAL    LAMBDA
29      C      DOUBLE PRECISION AK,DP1,DR
30      C      COMMON /ANT/AX,AY,AZ,LAMBDA,AK,DP1
31      C      COMMON /REC/RX,RY,RZ
32      C      COMMON /VAL/HR,HI
33      C      REAL L3,L1B
34      C
35      C      THIS IS THE INITIALIZATION SECTION
36      C      AY2=DOUBLE(AY)+DOUBLE(AZ)
37      C      AKK=BNGL(AK)
38      C      SF=Z2-Z1
39      C      CL=X2-X1
40      C
41      C      XMAX IS THE LENGTH ALONG THE SURFACE OF THE STRIP
42      C      XMAX=SQRT(SE*SE+CE*CE)
43      C
44      C      THESE ARE THE SIN AND COS OF THE ANGLE THE STRIP MAKES WITH
45      C      A HORIZONTAL PLANE
46      C      SE=SE/XMAX
47      C      CE=CE/XMAX
48      C      HR=0
49      C      JI=0
50      C
51      C      XL IS THE VARIABLE OF INTEGRATION. IT IS THE DISTANCE
52      C      LONG THE SURFACE OF THE STRIP STARTING FROM THE LEADING EDGE
53      C      XL=0,
```

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```
94      NX=1
95      LT=0
96
97      C      THESE ARE THE LOWER AND UPPER BOUNDS FOR THE SPACING BETWEEN
98      C POINTS ALONG THE VARIABLE OF INTEGRATION
99      L3=LAMBDA/24,
100     L1B=2B,*LAMBDA
101     A1=R1-X1
102     A2=R2-Z1
103     B1=X1
104     B2=Z1-A2
105     A=A1
106     TEMPB=A2
107     A=SQRT(A*A+TEMP*TEMP)
108     B=B1
109     TEMPB=B2
110     B=SQRT(B*B+TE,*TEMP)
111     TEMPB=AB
112     DR=DSQRT(DBLE(TEMP)*DBLE(TEMP)+DBLE(AV*AV))
113     C=DR
114     DR=DR*AK
115     I=DR/DPI
116     F=NR*DBLE(FLOAT(I))*DPI
117     C=C/TEMP
118     D=C*D
119     R=C*A
120     S=SQRT((1./A+1./B)/C/C/C)
121     G=A1/D/D/R/R/S
122     TEMP=G/(AKK*D)
123     CF=COS(F)
124     SF=SIN(F)
125     JOR=G*CF-TEMP*SF
126     JOI=G*SF-TEMP*CF
127     AP=(A1*CE-A2*SE)/A
128     BP=(A1*CE+B2*SE)/B
129
130      C      FP IS THE DERIVATIVE OF THE PHASE FUNCTION
131      C OF THE INTEGRAND
132      FP=ABS((AP+BP)/C)
133
134      C      DL IS DELTA XL
135      DL=L3/FP
136      IF(DL .GT. L1B) DL=L1B
137      IF(DL .LT. L3) DL=L3
138      XL=XL+DL
139
140      C      THIS IS THE LOOP OVER THE SURFACE OF THE STRIP. XL IS
141      C INCREMENTED BY DL (OF VARIABLE SIZE UNTIL THE END OF THE STRIP)
142      C IS REACHED (XMAX)
143      1      CONTINUE
144
145      C      THIS SECTION CALCULATE VARIOUS TERMS USED IN EVALUATING THE
146      C INTEGRAND. THE AMPLITUDE AND PHASE FUNCTION
```

118EN.FL

F4B

V27(368)

22-APR-76

1185

107 C ARE EVALUATED SEPARATELY. THE DERIVATIVE OF THE PHASE FUNCTION
108 C IS EVALUATED TO DETERMINE THE SIZE FOR DELTA X
109 DLSE=DL*SE
110 DLCE=DL*CE
111 A1=A1-DLCE
112 A2=A2-DLSE
113 B1=B1-DLCE
114 B2=B2-DLSE
115 A=A1
116 TEMP=A2
117 A= SORT(A*A+TEMP*TEMP)
118 B=RR1
119 TEMP=B2
120 B= SORT(B*B+TEMP*TEMP)
121 TEMP=A+B
122 DR=DSQRT(DBLE(TEMP)+DBLE(TEMP)+DBLE(AY*AY))
123 C=SQCL(DR)/TEMP
124 DR=DRAK
125 I=DR/DPI
126 C
127 C THIS IS THE PHASEE ANGLE +MODULO TWO PI
128 F=DR=DBBLE(FLOAT(I))/DPI
129 D=C*R
130 R=CA
131 S=SORT((1./A+1./B)/C)/C
132 G=A1/(D*D*R*R*S)
133 C
134 C THIS IS THE AMPLITUDE FUNCTION
135 TEMP=G/(AKK*D)
136 CE=COS(F)
137 SF=SIN(F)
138 C
139 C THIS IS THE REAL PART OF THE INTEGRAND FOR THE
140 C INTEGRATION VARIABLE VALUE OF XL
141 JNR=G*CF-TEMP*SF
142 C
143 C THIS IS THE IMAGINARY PART
144 JNI=G*SF+TEMP*CF
145 TEMP=DL
146 C
147 C THESE ARE THE REAL AN IMAGINARY PARTS OF THE THE SUMMATION
148 C OF THE TRAPIZOIDES MAKING UP THE APPROXIMATION TO THE INTEGRAL
149 JR=JN+(JDR+JNR)*TEMP
150 JI=JI+(JOI+JNI)*TEMP
151 IF(IT .NE. 0) GO TO 2
152 JDR=JNR
153 JOI=JN1
154 AP=(A1*CE-A2*SE)/A
155 BP=(B1*CE+B2*SE)/B
156 C
157 C FP IS THE DERIVATIVE OF THE PHASE FUNCTION
158 FP=ABS((AP+BP)/C)
159

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```

168      C DL IS DELTA X AND IS LIMITED BY THE ROUNDS L1,L12
169      DL=L3/PP
170      IF(DL .LT. L1B) DL=LB
171      IF(DL .LT. L3) DL=L3
172      AX=AX+1
173
174      C THE VARIABLE OF INTEGRATION IS INCREMENTED AND IF THE END OF THE
175      C STRIP IS REACHED THE LAST TRAPEZOID IS ADDED
176      XL=XL+DL
177      IF( XL .LT. XMAX ) GO TO 1
178      DL=XMAX+DL-XL
179      XMAX
180      ITA;
181      GO TO 1
182
183      C THIS SECTION ADDS THE FIELD EFFECT FROM THE STRIP TO THE
184      C TOTAL FIELD SUM AND THEN SUBROUTINE TERMINATES
185      CONTINUE
186      NM=1
187      TEMP=((Z1-A2)*CE-X1*SF)/2.
188      MRAW=JRC*TEMP
189      HIGH=MUL*TEMP
190
191      RETURN
192
193
  
```

CONSTANTS

```

F      285621280979
  
```

COMMON

```

X1      /SEG /+0      Z1      /SEG /+1      X2      /SEG /+2      Z2      /SEG /+3      N
AX      /ANT /+0      AV      /ANT /+1      AE      /ANT /+2      ANBDA /ANT /+0      AK
DPI     /ANT /+0      RX      /REC /+0      RV      /REC /+1      /REC /+2      MR
-MI     /VAL /+1
  
```

SUBPROGRAMS

```

DBLE   DFM.2  SGNL  SORT  DSORT  DIAZ.2  DFM.2  DFD.2  IDINT  FLOAT  DFS.0  DFD.0  COS  SIN  DFM.4
DFM.6  DFA.4  PFC.4  ABS  DFM.2  DFS.2
  
```

SCALARS

```

SUM    1064      A72      1065      AV      1      AKK    1067      AK      4
CE     1070      72      3      B1      1      CE    1071      X2      2
X1     0          XMAX    1272      JR      1873      J1    1074      XL      1075
XK     1077      IT      11P8      L3      1181      LAMBDA 3      L10     1102
A1     1103      RX      8      42      1189      R2      2      O1     1107
B2     1111      AE      2      4      1113      TEMP    1114      B      1119
DR     1110      C      1122      1      1121      DPI    6      F      1122
D      1123      R      1124      5      1125      G      1126      CF      1127
SF     1130      JOR    1131      JO1    1132      AP      1133      SP      1134
FP     1139      DL      1136      DLSE    1137      DLCE    1140      JNR    1141
  
```

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JAT	142	N	4	HE	0	MI	1	AX	0
PF	1								

A	69	67	71	79	80	87	119	117	121	130	131	134
A1	26	61	65	81	87	112	111	119	120	121	120	131
A2	26	62	66	87	112	116	124	122	121	120	121	120
AOS	92	158										
AK	29	38	37	74	124							
AKK	37	62	129									
ANT	39											
AP	87	92	154	156								
AR	29											
AT	28	36	72	122								
AV	26	36										
AW	26	36										
AZ	30	64	129									
B	69	70	71	79	80	88	119	120	121	120	131	135
B1	26	63	68	88	113	119	129	129	128	129	130	135
B2	26	64	69	88	114	119	129	129	128	129	130	135
BP	88	92	155	158								
C	73	77	78	79	88	92	123	129	130	131	130	135
CE	39	42	47	87	88	118	124	129	129	130	131	135
CF	83	85	86	136	141	144						
COB	83	136										
D	28	81	82	129	132	135						
DBLC	36	72	76	122	126	129						
DL	99	96	97	98	109	110	149	161	162	163	160	170
DLCK	118	111	113									
DLSE	109	112	114									
OPT	29	38	75	76	125	128						
OR	29	72	73	74	79	76	122	123	124	125	126	129
OSDNT	72	122										
F	76	83	84	126	134	137						
PLDAT	76	126										
PP	92	95	158	161								
G	81	82	49	86	132	139	141	144				
H1	32	101										
HR	32	100										
I	78	78	125	126								
IT	56	151	172									
J1	27	49	158	161								
JH1	27	144	158	153								
JNR	27	141	149	162								
JOT	27	86	158	153								
JOR	27	85	149	152								
JR	27	48	149	160								
L10	33	68	96	142								
LS	33	59	95	97	161	163						
LANODA	29	39	59	60								
M	29	170										
NX	94	164	178									
R	79	81	138	132								
REC	31											
RX	31	61										
RY	31											
RZ	31	62										
S	88	81	131	132								
SE	38	42	46	87	88	109	194	199	179			
SEG	25											
SIN	84	.85	86	137	141	144						
SMAL	37	123										
SORT	42	67	78	88	117	120	131					
SUM	24											
TEMP	46	67	69	78	71	72	77	82	85	88	116	117
VAL	121	122	123	139	141	144	145	149	150	179	180	181
X1	29	39	61	63	179							
X2	29	39										
XL	26	53	98	166	169	178	171					
XMAX	42	46	47	169	170	178						
Z1	28	38	62	64	178							
Z2	29	39										
19	183	169	173									
20	191	177										

APPENDIX B MOLE

MOLE_F4.FAB

V27(368)

23-APR-74

13:59

```

1      DIMENSION ILABL(8)
2      DIMENSION IPTDAT(33)
3      COMMON /PLXT/ NRP, RXMN, RXMX, RXFT, RXLT, RYMN, RYMX, RYFT, RYLT,
4      1RZMN, RZMX, RZFT, RZLT, RTMN, RTMX, RTFT, RRTL,
5      2A1MN, A1MX, A1FT, A1LT, ARMN, ARMX, ARFT, ARLT,
6      3ADIN, ADIX, ADIF, ADIL,
7      4ADRN, ADRX, ADRF, ADRL
8      EQUIVALENCE (IPTDAT(1),NRP)
9      IMPLICIT COMPLEX (C)
10     DIMENSION X(20), Y(20), Z(20)
11     DIMENSION CF1(20), CF2(20), CF3(20)
12     IMPLICIT DOUBLE PRECISION (D)
13     COMMON /NEC/RX,RY,RZ,RT,NSTDE
14     REAL LAMBDA
15     COMMON /ANT/ AX,AY,AZ,LAMBDA,DAK,DPI
16     COMMON /VAL/ MR,MJ
17     COMMON /GRND/ P(3,4),N(3)
18
19     C   THIS VALUE OF TWO PI IS INITIALIZED THIS WAY TO AVOID USING
20     C BLOCK DATA
21     DPI=6.2831853071795864769
22     WRITE(5,2001)
23     2001 FORMAT(' INPUT FILE NAME:',$)
24     READ(5,2000) ILBL
25     2000 FORMAT(A3)
26     CALL IFILE(21,ILBL)
27     WRITE(5,2002)
28     2002 FORMAT(' OUTPUT FILE NAME:',$)
29     READ(5,2000) ILBL
30     CALL OFILE(1,ILBL)
31     READ(20,4000) ((P(I,J),I=1,3),J=1,4)
32     4000 FORMAT(4(3G,/,))
33     READ(21,1000) ILABL,TAU
34     WRITE(1,1000) ILABL
35     00 3 I=1,2
36     READ(21,1000) ILABL
37     3    WRITE(1,1000) ILABL
38     1000 FORMAT(1A3,F)
39     READ(21) LAMBDA,NEL,(X(I),Y(I),Z(I),CF1(I),CF2(I),CF3(I),I=1,NEL)
40     WRITE(1) LAMBDA,NEL,(X(I),Y(I),Z(I),CF1(I),CF2(I),CF3(I),I=1,NEL)
41     DAK=DPI/DOBLE(LAMBDA)
42     201  READ(21,2000,END=200) RX,RY,RZ,RT,
43     1CFR1,CFR2,CFR3,CF81,CF82,CF83
44     2000 FORMAT(4F//,0E13.6,/,0E13.6)
45     READ(5,3000) P
46     3000 FORMAT(3B)
47     DO 5 I=1,NEL
48     AX(X(I))
49     AY(Y(I))
50     AZ(Z(I))
51     CTTEMP=(S,,S,,)
52     CALL INT2R(CTEMP)
53     CT=CTEMP*CF1(I)

```

MOLE, F4 F40 V27(368) 23-APR-78 13:52

```

46 CFR1>CFR1+CT
47 CF$1>CF$1+CT
48 CT>CTEMP>CF2(1)
49 CFR2>CFR2+CT
50 CF$2>CF$2+CT
51 CT>CTEMP>CF3(1)
52 CF$3>CF$3+CT
53 CFR3>CFR3+CT
54 CONTINUE
55 WRITE(1,2885) RX,RV,RE,RT,CFR1,CFR2,CFR3,CF$1,CF$2,CF$3
56 GO TO 281
57
58      THIS IS THE TERMINATION SECTION. THE INITIAL RECORD ON
59      THE OUTPUT FILE IS WRITTEN AND THE PROGRAM TERMINATES.
60
61      288 CALL RELEASE(1)
62      CALL EXIT
63      STOP
64      END.

```

CONSTANT

СОММО

WRP	/PLXT	/+8	RXNN	/PLXT	/+1	RXNN	/PLXT	/+2	RWFT	/PLXT	/+3	PRMN	/PLXT	/+14
RYNM	/PLXT	/+5	RYNN	/PLXT	/+6	RYFT	/PLXT	/+7	RYLT	/PLXT	/+10	RTMX	/PLXT	/+16
RZMN	/PLXT	/+9	REFT	/PLXT	/+13	PBLT	/PLXT	/+14	RTMA	/PLXT	/+15	RTMX	/PLXT	/+23
RTFT	/PLXT	/+19	RZLT	/PLXT	/+28	AJMN	/PLXT	/+21	AJMX	/PLXT	/+22	AJPT	/PLXT	/+30
AILT	/PLXT	/+24	ABMN	/PLXT	/+25	ARMX	/PLXT	/+26	ARFT	/PLXT	/+27	ARLY	/PLXT	/+35
ADIN	/PLXT	/+31	ADIX	/PLXT	/+32	ADIF	/PLXT	/+33	ADIL	/PLXT	/+34	ADRN	/PLXT	/+38
ACDX	/PLXT	/+36	ADOT	/PLXT	/+37	ADRL	/PLXT	/+40	AX	/ANT	/+6	AY	/ANT	/+1
RE	/REC	/+2	RT	/REC	/+3	REBC	/REC	/+4	AX	/ANT	/+6	AY	/ANT	/+2
AE	/ANT	/+2	LAMBDA	/ANT	/+3	DAM	/ANT	/+4	DPI	/ANT	/+6	MR	/VAL	/+8
									IPTDAT	/PLXT	/+8			

ANSWER

FORGE, STAFF ALPHON ALPHA. IFILE OFILE ALTA, FLOWT, FLIRT, BINNR, OBLE OFD,2 END, TWIN, VTR
RECALL, EXIT

SCALABR'

NP1	6	ILBL	466	I	487	J	488	TRU	1
LAMBDA	3	NEL	412	DAK	4	R3	5	CFR3	417
RE	2	BT	3	CFR1	413	CFR2	415	AY	1
CF51	421	CF52	423	CF53	425	AK	6	RXNN	1
AB	2	CTEMP	427	CT	431	WDP	6	RYMX	6
ABMX	2	RIFT	3	QXLT	4	RYNN	5	BFT	13
RIFT	7	RYLT	18	RENN	11	RYMX	12	RTLT	20
RBLT	14	RYMN	15	RYNK	16	RIFT	17	ARMN	29
AIMX	21	AIMX	22	AIFT	23	AILT	24		

REC	13			
RELEASES	68			
RT	13	42	63	
RIFT	3			
RLLT	3			
RTMN	3			
RTMX	3			
RX	13	42	63	
RXFT	3			
RXLT	3			
RXMN	3			
RXMX	3			
RY	13	42	63	
RYFT	3			
RYLT	3			
RYMN	3			
RYMX	3			
RZ	13	42	63	
RZFT	3			
RZLT	3			
RZMN	3			
RZMX	3			
TAU	33			
VAL	16			
X	18	39	48	48
Y	18	39	48	49
Z	18	39	48	50

3P	35	37		
5P	47	62		
202P	42	60		
201P	42	64		
1000P	33	34	36	37
2000P	24	25	29	
2001P	22	23		
2002P	27	28		
2003P	42	44	63	
3000P	45	46		
4000P	31	32		

HOLE,F4 F48 V27(368) 22-APR-76 13:53

```

1      SUBROUTINE NORMAL(V1,V2,V3,V4,R)
2      DIMENSION V1(4),V2(4),V3(4),V4(4)
3      X1=V2(1)-V3(1)
4      X2=V2(1)-V4(1)
5      Y1=V2(2)-V3(2)
6      Y2=V2(2)-V4(2)
7      Z1=V2(3)-V3(3)
8      Z2=V2(3)-V4(3)
9      X=V1(2)-V2(2)
10     Y=V1(2)-V3(2)
11     Z=V1(2)-V4(2)
12     R=SQR(X*X+Y*Y+Z*Z)
13     V1(1)=X/R
14     V2(1)=Y/R
15     V3(1)=Z/R
16     RETURN
17     END
  
```

GLOBAL DUMMIES

V1	133	V2	134	V3	135	V4	136	R	137
SUBPROGRAMS									
SORT									
SCALARS									
NORMAL	141	X1	142	X2	143	V1	144	V2	145
Z1	146	Y2	147	Y	139	V	131	Z	152
R	137								
ARRAYS									
V1	133	V2	134	V3	135	V4	136		
NORMAL	1	12	13	14	15				
R	1	12	2	3	4	5	6	7	8
SORT	12	1	2	3	4	5	6	7	8
V1	1	2	3	4	5	6	7	8	9
V2	1	2	3	4	5	6	7	8	9
V3	1	2	3	4	5	6	7	8	9
V4	1	2	3	4	5	6	7	8	9
X	1	12	13	14	15				
X1	1	12	13	14	15				
X2	1	12	13	14	15				
Y	1	12	13	14	15				
Y1	1	2	3	4	5	6	7	8	9
Y2	1	2	3	4	5	6	7	8	9
Z	1	12	13	14	15				
Z1	1	12	13	14	15				
Z2	1	12	13	14	15				
	1	2	3	4	5	6	7	8	9
	10	11	12	13	14	15	16	17	18
	19	20	21	22	23	24	25	26	27

HOLE,F4 F40

V27(360)

23-APR-76

13:53

```
1      DOUBLE PRECISION FUNCTION DIST(X,Y)
2      DIMENSION X(1),Y(1)
3      DOUBLE PRECISION R,TEMP
4      R=0.
5      DO 1 I=1,3
6      TEMP=X(I)-Y(I)
7      1   R=R+TEMP*TEMP
8      DIST=DSQRT(R)
9      RETURN
10     END
```

GLOBAL DUMMIES

X 56 Y 57

SUBPROGRAMS

DFM,2 DFAM,2 DSQRT

SCALARS

DIST 60 R 62 I 64 TEMP 65

ARRAYS

X 56 Y 57

DIST	1	0	
DSQRT	0		
I	3	0	
R	3	4	7
TEMP	3	6	7
X	1	2	6
Y	1	2	6

1P 5 7

MOLE.F4 F40

V27(360)

23-APR-76

13:55

```

1      SUBROUTINE INT02(CTEMP)
2      DATA DX,DY/23.,48./
3      DIMENSION XTA(3),ETA(3)
4      DOUBLE PRECISION D10,020,R10,R20
5      COMPLEX A,B
6      DOUBLE PRECISION D01,002
7      COMPLEX CTEMP,CCT,CCX,CCV,CCW
8      REAL N,LAMBDA,M1,M2,M3
9      COMMON /GRND/ P(3,4),N(3)
10     EQUIVALENCE (N(1),M1),(N(2),M2),(N(3),M3)
11     DOUBLE PRECISION DAK,DPI
12     COMMON /REC/ KR,YR,ZR
13     COMMON /ANT/XA,YA,ZA,LAMBDA,DAK,DPI
14     EQUIVALENCE (P11,P(1,1)),(P12,P(1,2)),(P21,P(2,1))
15     EQUIVALENCE (P24,P(2,4)),(P31,P(3,1)),(P34,P(3,4))
16     LOGICAL TEST
17     DATA TEST/.TRUE./
18     IF(TEST) CALL VNORMAL(P11,P12,P11,4),N(1),TEMP)
19     TEST=.FALSE.
20     IZ=2,024
21     TP1=SNGL(DPI)
22     AK=34GL(DAK)
23     CTEMP=(0.,0.)
24     DELX=0
25     DGE=0.137(D(1,1),D(1,2))
26     IX=DGE/DELX
27     IF(IK .LT. 0) IX=-IX
28     IF(IK .LT. 1) IX=1
29     IX=((IX-1)/2)+2
30     DELX=DGE/FLOAT(IX)
31     XTA(1)=(P(1,2)-P(1,1))/DGE
32     XTA(2)=(P(2,2)-P(2,1))/DGE
33     XTA(3)=(P(3,2)-P(3,1))/DGE
34     DGEX=XTA(1)*DELX
35     DGEX=XTA(2)*DELX
36     DGEX=XTA(3)*DELX
37     DG1=0.137(P(1,1),P(1,4))
38     DELRAY
39     IZ=0.61/DELB
40     IF(IK .LT. 0) IZ=-IZ
41     IF(IP .LT. 1) IZ=1
42     IZ=((IZ-1)/2)+2
43     DELB=DG1/FLOAT(IZ)
44     ETA(1)=(P(1,4)-P(1,1))/DG1
45     ETA(2)=(P(2,4)-P(2,1))/DG1
46     ETA(3)=(P(3,4)-P(3,1))/DG1
47     DG1=XTA(1)*DELB
48     DG1=YR*XTA(2)*DELB
49     DG1=XTA(3)*DELB
50     DO 1 IX=1,IX
51     FX=FLOAT(IX)-.5
52     XS=P(1,1)*FX*DGE
53     YS=P(2,1)*FX*DGE

```

WOLK, FG F48

V27(368)

23-APR-74

13:58

```

54      ZS=PF(3,1)+FX=0G02
55      DD_2_I22=1,1?
56      F2=FL0zT(182)-.5
57      X5=x5+f2=0G1X
58      VS+VS+f2=0G1Y
59      ZS=ZS+f2=0G1Z
60      CC5=xR.XS
61      CC7=xS-XR
62      TEMP0V8-V8
63      TEMP2=2R-2S
64      TEMP3=2R-2S
65      DR1=DRLE(CC6+CC6)+DRLE(TEMP+TEMP)
66      DR2=DR1+DRLE(TEMP3+TEMP3)
67      DR1=DR1+DRLE(TEMP2+TEMP2)
68      R12=R1
69      R22=R2
70      R1=R20RT(DR1)
71      R2=R20RT(DR2)
72      R1=R3
73      R2=R2
74      TEMP0V8-V8
75      TEMP3=2S-2A
76      TEMP3=2S-2A
77      DR1=DRLE(CC7+CC7)+DRLE(TEMP+TEMP)
78      DR2=DR1+DRLE(TEMP3+TEMP3)
79      DR1=DR1+DRLE(TEMP2+TEMP2)
80      R12=R1
81      R22=R2
82      R17=R20RT(DR1)
83      R22=R20RT(DR2)
84      D1=D10
85      D2=D20
86      R17=42*x5*(VR-VS)+(41*x5*x3*(2S-2A))+((VR-XS)
87      R22*x5*(VR-XS)+2A2
88      COSA0(XTA(1)+CC7+XTA(2)*(VS-VA)+XTA(3)*(2S-2A))/D1
89      COSA3(XTA(1)+CC7+XTA(2)*(VS-VA)+XTA(3)*(2S-2A))/D2
90      COSG0(XTA(1)+CC6+XTA(2)*(VR-VS)+XTA(3)*(2R-2S))/R1
91      COSG3(XTA(1)+CC6+XTA(2)*(VR-VS)+XTA(3)*(2R-2S))/R2
92      COSB0(ZTA(1)+CC7+ZTA(2)*(VS-VA)+ZTA(3)*(2S-2A))/C1
93      COSB3(ZTA(1)+CC7+ZTA(2)*(VS-VA)+ZTA(3)*(2S-2A))/C2
94      COSD0(ZTA(1)+CC6+ZTA(2)*(VR-VS)+ZTA(3)*(2R-2S))/R1
95      COSD3(ZTA(1)+CC6+ZTA(2)*(VR-VS)+ZTA(3)*(2R-2S))/R2
96      CM=COSA-COSG
97      CM1=cosA1-COSG1
98      CM2=cosA1-COSG
99      CM3=cosA1-COSG;
100     C=COSB-COSD
101     C1=COSA-COSD1
102     C2=COSA1-COSD
103     C3=COSA1-COSD1
104     D17=R17+7AK
105     D22=R22+7AK
106     R1P=R17+7AK

```

MOLE, P4 P40 V27(360) 23-APR-76 13:58

```

187 R2=R2*C0*QAK
188 ID=018//DPI
189 D1=018-DBLE(FLOAT(ID))=DPI
190 ID=028//DPI
191 D2=D28-DBLE(FLOAT(ID))=DPI
192 IDA18//DPI
193 R1=R18-DBLE(FLOAT(ID))=DPI
194 ID=028//DPI
195 R2=R28-DBLE(FLOAT(ID))=DPI
196 TEMP1=SIN(AK+CH0*DELX0,.9)*SIN(AK+C0*DELX0,.9)/(CH0*C0*D12*R12)
197 CTENP=CTEMP0-TE*PCEXP((CMPLX(0.,D1-R1)))
198 TEMP2=SIN(AK+CH1*DELX1,.9)*SIN(AK+C1*DELX1,.9)/(CH1*C1*D12*R22)
199 CTENP=CTEMP0-TE*PCCFXP((CMPLX(0.,D1-R2)))
200 TEMP3=SIN(AK+CH2*DELX2,.9)*SIN(AK+C2*DELX2,.9)/(CH2*C2*D22*R22)
201 CTENP=CTEMP0-TE*PCEXP((CMPLX(0.,D2-R1)))
202 TEMP4=20*SIN(AK+CH3*DELX3,.9)*SIN(AK+C3*DELX3,.9)/(CH3*C3*D22*R22)
203 CTENP=CTEMP0-TE*PCEXP((CMPLX(0.,D2-R2)))
204 CONTINUE
205
206 CONTINUE
207 CTENP=CTEMP0+2.//(TP1+TP2)
208 ICC=1*X1*E
209 RETURN
210 END

CONSTANTS
 0 888888888888 1 FFFFFFFFFFFF 2 F0000000001 3 000000000000

GLOBAL DUMMIES
CTEMP 1341

COMMON
  P /GRND /*8
  XA /ANT /*8
  YA /ANT /*8
  ZA /ANT /*8
  YR /REC /*8
  ZR /REC /*2
  VR /GRND /*15
  LAMBDA /REC /*3
  GRND /GRND /*16
  P12 /GRND /*3
  P21 /GRND /*1
  P24 /GRND /*12
  P31 /GRND /*1

SUBPROGRAMS
NORMAL SNGL DBLTF DFAT,FLOAT DBLE DFA,E DFAM,S DBRT DFMM,Z DFZ,
  8 4 CEXP CMPLX CFM,R FFD,4

SCALARS
INTR2 1347 OX 1392 DV 1391 TEST 1392
P12 3 TEMP 1393 DA2 1394 ZA 2
DPI 6 AK 1396 ZAK 4 CTEMP 1341
DGP 1368 IX 1361 DGPM 1362 DGPY 1363
DGS 1349 CEL2 1366 IZ 1367 DGIX 1370
DG18 1372 IXK 1373 FX 1374 X8 1375
ZS 1377 E2 1408 FZ 1401 CG6 1402

```

HOLE, F4 F4B	V27(368)	23-APR-76	14:08								
CC7	1483	X4	P	V4	1	TLMF2	1484	Z8	2		
TEMP3	1495	R41	1488	182	1418	R12	1412	R22	1413		
A18	1414	R20	1416	81	1428	R2	1425	V8	1		
D12	1422	D22	1423	78	1424	D28	1420	D1	1438		
P2	1431	F10	1432	2	15	V1	14	V3	16		
F2P	1433	COSA	1434	COSA1	1439	COSG	1436	COSG1	1437		
COS8	1449	COSB1	1441	COSD	1442	COSC1	1443	CH	1444		
CM1	1445	CH2	1446	CW3	1447	C	1450	C1	1451		
C2	1452	C3	1453	17	1454	ICC	1455	LAMBDA	3		
P21	1	P24	12	P31	2	P34	13				

ARRAYS

WTA	1456	ZTA	1461	P	E	N	14
-----	------	-----	------	---	---	---	----

A	5										
AK	22	116	118	128	122						
ANT	13										
B	5										
C	168	116									
C1	181	118									
C2	182	128									
C3	183	122									
CDA	48	65	98	91	94	95					
CC7	61	77	88	49	92	93					
CCT	7										
CDX	7										
CCW	7										
CCV	7										
CEXP	117	119	121	123							
CH	96	116									
CH1	97	118									
CH2	98	128									
CH3	99	122									
CMPLX	117	119	121	123							
COSA	88	96	97								
COSA1	89	98	99								
COSB	92	108	121								
COSB1	93	102	123								
COSD	94	108	122								
COSD1	95	101	123								
COSG	98	96	98								
COSG1	91	97	99								
CTEMP	1	7	23	117	118	121	123	126			
O	29										
D1	64	88	92	129	117	118					
D1B	4	82	84	124	128	129					
D12	88	116	118								
D2	85	89	93	111	121	123					
D2B	4	83	85	125	118	111					
D22	81	128	122								
DAK	11	13	22	124	105	106	127				
DBLX	65	66	47	77	78	79	109	111	113	115	
DELK	24	26	38	34	39	36	110	118	120	122	
DEL2	38	39	43	47	48	49	116	118	120	122	
DG8	25	26	39	31	32	33					
DG7	34	52									
D1%	39	53									
D1	36	54									
D11	37	39	43	44	49	48					
D1X	47	57									
D1Y	48	58									
D1Z	49	59									
D1ST	25	37									
DPI	11	13	21	128	109	112	111	112	113	114	115
DP1	6	65	66	67	68	78	77	78	79	80	82
DP2	6	66	69	71	78	81	83				
D80RT	78	71	82	83							

APPENDIX C GLDCDI

```

1      DIMENSION ILBL(8)
2      DIMENSION IPTDAT(33)
3      COMMON /PLXT/ NRP,RXMN,RXMX,RXFT,RXLT,RVMN,RVMX,RVFT,RVLT,
4      RZMN,RZMX,RZFT,RZLT,RTMN,RTMX,RTFT,RTLT,
5      ZAMN,AIMX,AIFT,AILT,AMMN,ARMX,ARFT,ARLT,
6      JADIN,ADIX,ADIC,ADIL
7      4ADRN,ADRX,ADRZ,ADRL
8      EQUIVALENCE (IPTDAT(1),NRP)
9      IMPLICIT COMPLEX (C)
10     DIMENSION X(20),Y(20),Z(20)
11     DIMENSION CF1(20),CF2(20),CF3(20)
12     IMPLICIT DOUBLE PRECISION (D)
13     COMMON /REC/RX,RY,RZ,RT,NSIZE
14     REAL LAMBDA
15     COMMON /GROUND/ K,X1(20),Z1(20),X2(8/20),Z2(8/20),IEL
16     COMMON /ANT/AZ,AY,AZ,LAMBDA,DAK,DPI
17     COMMON /VAL/ MR,MJ
18
19     C   THIS VALUE OF TWO PI IS INITIALIZED THIS WAY TO AVOID USING
20     C BLOCK DATA
21     DPI=6.2831853071799864769
22     WRITE(5,2001)
23     2001 FORMAT(' INPUT FILE NAME:',S)
24     READ(5,2001) ILBL
25     2002 FORMAT(A9)
26     CALL FILE(20,ILBL)
27     WRITE(5,2002)
28     2003 FORMAT(' OUTPUT FILE NAME:',S)
29     READ(5,2003) ILBL
30     CALL FILE(1,ILBL)
31     WRITE(1) IPTDAT
32     READ(1,1000) ILBL,TAU
33     WRITE(1,1000) ILBL
34     DO 3 I=1,2
35     READ(20,1000) ILBL
36     3  WRITE(1,1000) ILBL
37     1000 FORMAT(8A5,F)
38     READ(20) LAMBDA,NEL,(X(I),Y(I),Z(I),CF1(I),CF2(I),CF3(I),I=1,NEL)
39     201  READ(20,2005,END=200) RX,RY,RZ,RT,
40           1CFR1,CFR2,CFR3,CFS1,CFS2,CFS3
41     2005 FORMAT(4F,/,6E13.6,/,6E13.6)
42
43     C   AFTER THE FIELDS HAVE BEEN ACCUMULATED FOR ALL THE ELEMENTS
44     C   THE CDI'S ARE CALCULATED
45     C       ACDR  CDI FOR THE GROUND SURFACE
46     C       ACDI  CDI FOR 'IDEAL' GROUND PLANE
47     ACDR=897.14*REAL((CFR2-CFR3)/CFR3)
48     ACDI=897.14*REAL((CFS2-CFS3)/CFS3)
49
50     C   NRP IS THE COUNT OF THE RECEIVERPOINTS
51     NRP=NRP+1
52     IF(NRP .NE. 1) GO TO 4
53     C

```

GLDG01.F4

F40

V27(36P)

22-APR-76

11104

```

54      C THIS SECTION INITIALIZES THE MAXIMUM AND MINIMUM VALUES
55      C OF THE VARIOUS RANGE AND DOMAIN VARIABLES. THESE ARE
56      C USED IN THE PLOTTING PROGRAM TO SCALE THE PLOTS. AFTER THE
57      C RUN IS FINISHED THEY WILL BE OUTPUT IN PLACE OF THE
58      C INITIAL DUMMY RECORD
59      ADD1=ACD1
60      ADD2=ACD2
61      TD=RT
62      ADIX=ACD1
63      ADIN=ACD1
64      ADIF=ACD1
65      ADRX=ACD2
66      ADRN=ACD2
67      ADRF=ACD2
68      RXFT=RX
69      RYFT=RY
70      REFT=RZ
71      RTF=RT
72      AIFT=ACD1
73      ARFT=ACD2
74      RXMN=RX
75      RXMX=RX
76      RYMN=RY
77      RYMX=RY
78      RENMRE
79      RENXRE
80      RTHNORT
81      RTHXORT
82      AIMX=ACD1
83      AIMN=ACD1
84      ARMX=ACD2
85      ARMN=ACD2
86      C
87      C THIS SECTION UPDATES THE MAXIMUM AND MINIMUM VALUES
88      4
89      CONTINUE
90      RXLT=RX
91      RYL=RY
92      RZLT=RZ
93      RTLT=RT
94      AILT=ACD1
95      ARLT=ACD2
96      IF(RX .LT. RXMN) RXMN=RX
97      IF(RY .GT. RXMX) RXMX=RX
98      IF(RY .LT. RYMN) RYMN=RY
99      IF(RY .GT. RYMX) RYMX=RY
100     IF(RZ .GT. R2MX) R2MX=R2E
101     IF(RZ .LT. R2MN) R2MN=R2E
102     IF(RT .GT. RTMX) RTMX=RT
103     IF(RT .LT. RTMN) RTMN=RT
104     IF(ACD1 .GT. AIMX) AIMX=ACD1
105     IF(ACD1 .LT. AIMN) AIMN=ACD1
106     IF(ACD2 .GT. ARMX) ARMX=ACD2
107     IF(ACD2 .LT. ARMN) ARMN=ACD2

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```

GLOC01.F4 F48 V27(568) 22-APR-76 11104

1P7      DD1=EXP((TB-RT)/TAU)
120
121 C THIS SECTION SIMULATES THE EFFECT OF THE ELECTRICAL AND
122 C MECHANICAL 'INERTIAL' OF THE ILS
123 C RECEIVER SYSTEM FOR DYNAMIC SIMULATION
124      TB=RT
125      ADD1=CON4*(ADD1-ACD1)+ACD1
126      ADD2=CON4*(ADDR-ACDR)+ACDR
127      IF((ADD1 .LT. ADDN) .AND. ADD1>ADD2)
128      IF((ADD1 .GT. ADDN) .AND. ADD1<ADD2)
129      ADD1=ADD1
130      IF((ADDR .LT. ADDN) .AND. ADDR>ADDR)
131      IF((ADDR .GT. ADDN) .AND. ADDR<ADDR)
132      ADDR=ADDR
133
134 C THIS IS THE OUTPUT OF THE REAL AND 'IDEAL' , STATIC
135 C AND DYNAMIC CDI'S WITH THE RECEIVER COORDINATES
136 C WRITE(1,2003) R,RY,RZ,RT,ACD1,ACD2,ADDR,ACDR
137      2003 FORMAT(10F7)
138      GO TO 281
139
140 C THIS IS THE TERMINATION SECTION. THE INITIAL RECORD ON
141 C THE OUTPUT FILE IS WRITTEN AND THE PROGRAM TERMINATES,
142 C CALL RELEASE (1)
143      ENCODE (9,2006,ILAB(1)) TLBL
144      2006 FORMAT(10F7,'.DAT')
145      CALL DEFINE FILE(1,25,1,ILAB(1))
146      WRITE(105) IPTDAT
147      CALL RELEASE (1)
148      CALL EXIT
149      STOP
150      END

CONSTANTS

8      203622077325      1      158842859861      2      000000000024      3      000000000001      4      212034443096
9      000000000031

COMMON

NRP    /PLXT /+0     RXMN    /PLXT /+1     RXMX    /PLXT /+2     RXPT    /PLXT /+3     RXLT    /PLXT /+4
RNM    /PLXT /+5     RYMX    /PLXT /+6     RYFT    /PLXT /+7     RYLT    /PLXT /+10    RHMN    /PLXT /+11
RMN    /PLXT /+12    RZFT    /PLXT /+13    RZLT    /PLXT /+14    RTMN    /PLXT /+15    RTMX    /PLXT /+16
RTFT   /PLXT /+17    RTLT    /PLXT /+20    AIMN    /PLXT /+21    AIMX    /PLXT /+22    AIFT    /PLXT /+23
AIFT   /PLXT /+24    ARMN    /PLXT /+25    ARMX    /PLXT /+26    ARFT    /PLXT /+27    ARLT    /PLXT /+28
ADMN   /PLXT /+31    ADIX    /PLXT /+32    ADIF    /PLXT /+33    ADIL    /PLXT /+34    ADRN    /PLXT /+35
ADRN   /PLXT /+36    ADRI    /PLXT /+37    ADRL    /PLXT /+40    RX    /REC /+0     RY    /REC /+1
RE    /REC /+2     RT    /REC /+3     RZIRE    /REC /+4     K    /GROUND /+8     X1    /GROUND /+1
21    /GROUND /+9     X2    /GROUND /+51    E2    /GROUND /+70     TEL    /GROUND /+123    AX    /ANT /+0
AT    /ANT /+1     A2    /ANT /+2     LAMBDA /ANT /+3     OAK    /ANT /+4     DP1    /ANT /+0
MR    /VAL /+0     M1    /VAL /+1     IPTDAT /PLXT /+0

SUBPROGRAMS

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SLB501,F4	F48	V27(368)	22-APR-78	11184												
FORGE, VADD,	JOFF DEFINE	ALPHO.	ALPHI.	IFILE	OFIL	SINHP,	FLOUT,	FLIRT,	EVO.	REAL	CFB.2	EXP	CFW.2	RELEASE		
SCALARS																
DPI	6		TLBL	967		TAU	978		1	971		LAMDA	13			
WEL	972		RX	8		RY	1		88	2		RT	3			
CFR1	973		CFR2	979		CFR3	977		CFB1	981		CFB2	983			
CFB3	685		ACDR	687		ACDI	618		WDP	8		ADD1	611			
ADDR	612		TG	613		ADIX	32		ADIN	31		ADIF	33			
ADPF	30		ADRN	33		ADRF	37		ADFT	3		ADFI	27			
ADRN	13		RTFT	17		AIFT	23		ADFT	27		RTFI	2			
RIMX	2		RIMN	9		RIMX	6		RIMN	15		RIMX	18			
RIMN	15		RIMX	16		RIMX	22		RIMN	21		RIMX	26			
ARMX	29		RILT	4		RYLT	10		RILT	14		RYLT	29			
AILT	24		ARLT	30		COV	614		ADIL	34		ADRL	48			
NRBLK	4		K	8		TEL	123		AF	8		AY	3			
AE	2		DAK	4		MR	8		HI	1						
ARRAYS																
ILABL	616		IPTDAT	8		X	626		V	692		R	676			
CF1	782		CF2	772		CF3	1842		XL	1		SL	18			
X2	91		22	76												
ACB1	48	59	62	63	64	72	82	84	85	93	103	104	113	124		
ACB4	47	60	65	66	67	73										
ADBL	39	113	115	116	117	124										
ADBR	60	114	118	119	120	124										
ADIF	3	64														
ADIL	3	117														
ADIN	3	63	115													
ADIX	3	62	116													
ADRF	3	67														
ADRL	3	129														
ADRN	3	66	110													
ADRX	3	65	119													
AIFT	3	72														
AILT	3	93														
AIMN	3	81	184													
AIMX	3	82	193													
ANT	16															
ARFT	3	73														
ARLT	3	94														
ARMX	3	85	186													
ARMX	3	84	195													
AX	16															
AY	16															
AB	16															
CF1	11	38														
CF2	11	38														
CF3	11	38														
CFB1	39	47														
CFB2	39	47														
CFB3	39	47														
CFB4	39	48														
CFB5	39	48														
CFB6	39	48														
CON	107	113	114													
DAK	16															
DEFINE	133															
OPI	16	21														
EXIT	136															
EXP	107															
GROUND	15															
HI	17															
HR	17															
I	34	38	133													
TEL	19															
IFILE	26															
ILABL	1	37	33	35	36	131	133									
ILBL	24	26	29	30	31	134										
IPTDAT	2	8	31	134												
X	19															
LAMDA	14	16	30													
MEF	38															
MRD	3	8	51	52												
NRBLK	13															

OFILC	38													
PLAT	3													
REAL	47	48												
REC	13													
RELEASE	136	135												
RT	13	39	61	71	88	81	92	101	102	107	118	124		
RTPT	3	71												
RTLT	3	92												
RTMN	3	87	132											
RTME	3	81	121											
RX	13	39	60	74	79	89	95	96	124					
REFT	3	58												
RHLT	3	89												
RXMR	3	74	95											
RXMK	3	75	96											
RY	13	39	69	76	77	88	97	98	124					
RYPT	3	69												
RYLT	3	97												
RYMN	3	74	97											
RYMX	3	77	98											
RZ	13	39	78	78	79	81	99	100	124					
RZPT	3	72												
RZLT	3	91												
RZMN	3	78	126											
RZME	3	79	99											
TAJ	61	107	112											
VAL	38	127												
X	18	38												
X1	19													
X2	19													
Y	18	38												
Z1	18	38												
Z2	19													
3P	34	36												
4P	52	68												
283P	39	132												
281P	39	126												
1002P	32	33	35	36	37									
288PP	24	25	79											
2861P	22	21												
2882P	27	28												
2883P	124	125												
2889P	39	41												
2886P	131	132												

APPENDIX D GLDPLT

GLDPLT.F4 F4B V27(362) 22-APR-78 11:04

```

1                    DIMENSION ITYPE(3,2)
2                    DATA ITYPE/'STAT1','C VAL','UES','DYNAMIC','LG VA','LUES'
3                    DATA PID,PRD/'CDID','THEOD'/
4                    DIMENSION SPACE(4),IAX(2,3)
5                    DATA SPACE/1.,2.,2.5,3./
6                    DATA IAX/'DEGRE','ES',' FEET',' ','SECOND','OS'/
7                    DATA PRX,PRY,PRZ,PAT,PAR/
8                    |'RX','RY','RZ','RT','CDI','THEO'/
9                    DIMENSION IPTDAT(33)
10                  COMMON /PTXXN/NRP,RXMN,RXMX,RXFT,RXLT,RYMN,RYMX,RYFT,RYLT,
11                  |RZMN,RZMX,RZFT,RZLT,RTHN,RTMX,RTFT,RTLT,
12                  |ZAIN,AIMX,AIFT,AILT,ARMN,ARMX,ARFT,ARLT,
13                  |JADIN,ADIN,ADIF,ADIL,ADRN,ADRX,ADRF,ADRL
14                  EQUIVALENCE (IPTDAT(1),NRP)
15                  DIMENSION ILBL(8)
16                  DATA XLEN,YLEN,ITIC/20.,8.,21/
17                  DIMENSION DYI(2000)
18                  DIMENSION DX(2000),DY(2000)
19                  NAMELIST /FREQ,YLENG,YDEL,YSC,DMIN,DMAX,DEL,IP,XSC
20                  CALL PLOTS(1BUF,360,16)
21                  3                  WRITE(3,1000)
22                  1000             FORMAT(' INPUT FILE NAME AND AXIS TYPES',:)
23                  READ(3,1000) NAME,ISX,ISY,BOUND
24                  1005             FORMAT(A9,I,I,F)
25                  IF(ISY .LT. 1) GO TO 204
26                  IF(ISY .GT. 2) GO TO 204
27                  IF(ISX .LT. 1) GO TO 204
28                  IF(ISX .GT. 3) GO TO 204
29                  CALL PLOT(8,--12,,-3)
30                  CALL PLOT(8,,-1,,-3)
31                  100
32                  CALL IFILE(20,NAME)
33                  READ(20) IPTDAT
34                  WRITE(3,1002) NRP
35                  1002             FORMAT(' THERE ARE',I9,' RECEIVER POINTS',/,/)
36                  WRITE(3,1003)
37                  1003             FORMAT(14X,'MIN',9X,'MAX',9X,'FIRST',8X,'LAST',/)
38                  1004             FORMAT(1X,A5,1X,4F12.4)
39                  WRITE(3,1004) PRX,RXMN,RXMX,RXFT,RXLT
40                  WRITE(3,1004) PRY,RYMN,RYMX,RYFT,RYLT
41                  WRITE(3,1004) PRZ,RZMN,RZMX,RZFT,RZLT
42                  WRITE(3,1004) PAT,RTHN,RTMX,RTFT,RTLT
43                  WRITE(3,1004) PAR,ARMN,ARMX,ARFT,ARLT
44                  WRITE(3,1004) PID,ADIN,ADIF,ADIL
45                  WRITE(3,1004) PRD,ADRV,ADRX,ADRF,ADRL
46                  GASD00,
47                  GASU0,
48                  GARN00,
49                  DO 7 II=1,3
50                  READ(20,100) ILBL
51                  WRITE(3,101) ILBL
52                  101             FORMAT(1X,B5)

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GLOPLT.F6 F48 V27(368) 22-APR-78 11:04
 94 100 FORMAT(8A9)
 95 CALL SYMBOL(0..0..2,ILABL,98..48)
 96 7 CALL PLOT(.3,0..-3)
 97 CALL SYMBOL(0..0..2,ITYPE(1,ISY),98..19)
 98 CALL PLOT(2.,0..-3)
 99 1 READ(2D,1000,END=2) X,Y,Z,T,C,R,CD,RD
 60 FORMAT(8F)
 61 TEMPSORT(X0X+Y0Y)
 62 IF((TEMP .LT. 3500.) .OR. (TEMP .GT. 2P720.)) GO TO 60
 63 GASURGASU=C
 64 GASDGASD=CD
 65 GACNGAC4=1.
 66 CONTINUE
 67 I=I+1
 68 GO TO (300,301) ISY
 300 302 CONTINUE
 301 DY(1)=C
 302 DY1(1)=R
 303 GO TO 302
 301 DY(1)=CD
 302 DY1(1)=RD
 302 CONTINUE
 303 GO TO (200,201,202) ISX
 200 DX(1)=ATAN2(Z,SQRT(X0X+Y0Y))+57.2953
 200 GO TO 199
 201 DX(1)=X
 200 GO TO 199
 202 DX(1)=T /
 200 GO TO 199
 199 IF(I .NE. 1) GO TO 198
 198 DMIN=DX(1)
 199 DMAX=DX(1)
 198 DMIN=AMIN1(DMIN,DX(1))
 199 DMAX=AMAX1(DMAX,DX(1))
 1991 FORMAT(5X,3F)
 199 IF(I .LT. 2000) GO TO 1
 2 IF(I .LT. 2) GO TO 3
 91 YLENG=AMAX1(AINX,ABS(BOUND),-AIMN,B.)
 92 IF(ARS(BOUND) .LT. 1.E-4) GO TO 10
 93 YDELBYLENG
 94 GO TO 11
 95 10 YLENG=AMAX1(YLENG,ARMX,-ARMN)
 96 YDEL=FLOAT(IFIX(YLENG/YLEN))
 97 YLEN=YDEL*YLEN
 98 11 CALL AXIS3(0..-YLENG,YLENG,YDEL,YLEN,
 99 1'MICROAMPERES',12,0,0.,YSC)
 100 IP=IFIX(ALOG10(DMAX-DMIN))-1
 101 POW=10.9*IP
 102 DO 120 J=1,4
 103 DEL=SPACE(J)*POW
 104 IT=IFIX(DMAX/DEL-1.)+1-IFIX(DMIN/DEL)
 105 IF(IT .LT. ITIC) GO TO 121
 106 120 CONTINUE

GLOPLT.F4 F48 V27(362) 22-APR-76 11184
 FORSE, JOFF ALLOC. PLOTS ALPHO. ALPHI. INTL. INITL. FLOUT. FLIRT. PLOT. ISFILE BINWR. SYMBOL END.
 SOUT ATAN2 AMIN1 ANAX1 ABS FLOAT IFIX AX183 ANALGIF EXP2.2 NRBLT, EXIT

SCALARS

PID	1230	PRO	1231	PRX	1232	PRY	1233	-	PRE	1234
PRT	1235	PAI	1236	PAR	1237	XLEN	1240	-	YLEN	1241
ITIC	1242	YLENG	1243	VOEL	1244	VSC	1249	-	DMIN	1246
OMAE	1247	DEL	1250	IP	1251	NOC	1252	-	IBUF	1253
NAME	1254	ISX	1255	ISV	1256	OUND	1257	I	1260	
NPB	0	RXNN	1	RNNX	2	RXFT	3	-	RXLT	4
RYMN	5	RYMX	6	RYFT	7	RYLT	10	-	RMHN	11
RZNM	12	RZFT	13	RZLT	14	RTNH	19	-	RTMX	16
RTFT	17	RTLT	20	AIMN	21	AIMX	22	-	AIFT	23
AILT	24	ARNN	25	ARMX	26	ARFT	27	-	ARLT	30
ADIN	31	AOIX	32	ADIF	33	ADIL	34	-	ADRN	35
ADRN	36	ADRF	37	ACRL	40	CASD	1261	-	CASU	1262
GDN	1263	II	1264	X	1265	Y	1266	Z	1267	
T	1270	C	1271	R	1272	CD	1273	-	RD	1274
TEMP	1275	POW	1276	J	1277	IT	1300	-	ISW	1301

ARRAYS

ITYPE	1302	SPACE	1310	IAX	1314	IPTDAT	0	-	ILABL	1322
OY1	1332	DX	5252	OY	11172					

J	182	183	122	123	124	128	129						
NAME	23	32											
MP	18	14	34										
PAI	7	43											
PAR	7	44											
PID	3	45											
PLOT	29	37	56	58	112	113	119	124	127	129	131	133	
PLOTS	28												
POW	181	183											
PRO	3	46											
PRT	7	42											
PRX	7	39											
PRY	7	47											
PRZ	7	41											
RIMXH	18												
R	59	71											
RQ	59	74											
RFPT	18	42											
RLLT	18	42											
RMN	18	42											
RIMX	18	42											
RYFT	18	39											
RXLT	18	39											
RXMN	18	39											
RXMH	18	39											
RYFT	18	49											
RYLT	18	42											
RYMN	18	42											
RYMX	18	48											
RZFT	18	41											
RZLT	18	41											
RENN	18	41											
RZMX	18	41											
SPACE	4	5	183										
SORT	61	77											
SYMBOL	55	57											
T	59	81											
TEMP	61	62											
X	59	61	77	79									
XLEN	18	111	113	131									
XSC	19	111	115	124	127	129							
Y	59	61	77										
YDEL	19	93	96	97	98								
YLEN	18	96	97	98	112								
YLENG	19	91	93	95	96	97	98						
YSC	19	98	115	124	127	129							
Z	59	77											

GLDPLOT.F9

F4B

V27(362)

22-APR-76

11:04

```

1      SUBROUTINE AXIS3(XB,YB,AMAX,AMIN,DELA,AINCH,BCD,NCR,NDEC,PWR,DELN)
2      DIMENSION BCD(1)
3      HT = .1B
4      DELA=SIGN(DELA,(AMAX-AMIN))
5      W1=0,
6      W2=0,
7      W3 = B,
8      NEXP = 0
9      NCH=IABS(NCR)
10     IF(PWR.NE.0.) NEXP = 6
11     CINCH=ABS(AINCH)
12     IF((ABS(AMAX-AMIN)*ABS(DELX).LT.1.E-5) GO TO 30
13     IF((AMAX-AMIN)/(DELX+1.E-5).GT.3.*CINCH) DELX = (AMAX-AMIN)/CINCH
14     IF(NCR.LT.0) W3 = 1.
15     NUM=IFIX((AMAX-AMIN)/DELX+1.9)
16     ANC=CINCH/FLOAT(NUM-1)
17     IF(AINCH.LT.0.)GO TO 5
18     W2=1,
19     GO TO 10
20     W1=1,
21     CALL PLOT(XB,YB,3)
22     DELN=DELX/10.*PWR/ANC
23     ANUM=AMIN+DELX
24     X=B,
25     Y=B,
26     XM=0,
27     DO 49 I=1,NUM
28     ANUM=ANUM+DELX
29     II=0
30     IF(ABS(ANUM)/10..0..).LT.1.)GO TO 22
31     II=II+1
32     GO TO 25
33     20 IF(ANUM.LT.0.)II=II+1
34     IF(ABS(ANUM).LT.1.) II=II+1
35     IMORE=NDEC+1
36     II=II+IMORE
37     IF(IFIX(W1)+1.E0,1) HT = AMIN1(HT ,ANC,FLOAT(II+2))
38     CENTER = FLOAT(II)*HT/(1.+W1)
39     OFF = .05
40     XC = X - CENTER + W2*(W3*(.3B+CENTER) -.1B)
41     YC = Y - W1*(HT + .1B - W3*(HT+.3)) - W2*OFF
42     CALL PLOT(XB+X,YB+Y,2)
43     CALL PLOT(XB+X+.1*W2,YB+Y+.1*W1,3)
44     CALL PLOT(XB+X-.1*W2,YB+Y-.1*W1,2)
45     CALL NUMBER(XB+XC,YB+YC,HT,ANUM,0.,NDEC)
46     CALL PLOT(XB+X,YB+Y,3)
47     X=X+ANC*W1
48     Y=Y+ANC*W2
49     40 CONTINUE
50     BST = (CINCH - FLOAT(NCH+NEXP)*.12)/2,
51     XXC = W1*(XB + BST) + W2*(XB + XM + OFF + W3*(2.*CENTER+.44))
52     YYC = W1*(YB + YC -.17 + W3*(HT + .22)) + W2*(YB + BST)
53

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GLOPLT.F4 F48 V29(36C) 22-APR-76 11:04

```

  94      CALL SYMBOL(XXC,YYC,.12,RCD,98,0W2,NCM)
  95      IF(PHR,ED,0,) RETURN
  96      CALL WHERE(XQ,YQ,XXC)
  97      CALL SYMBOL(XQ,YQ,.12,5H + 18.98+0W2,0)
  98      CALL WHERE(XQ,YQ,XXC)
  99      X = YQ + (XXC-.98-XQ)0W2
  100     Y = YQ + (YYC-.98-YQ)0W1
  101     CALL NUMBER(X,Y,.09,PHR,98,0W2,-1)
  102     RETURN
  103     9E DELN = 1.E-3*18.0+PHR/CINCH
  104     N=NCR/5
  105     WRITE(5,1000) AMAX,AMIN,DELA,PHR,(BCD(I),I=1,N)
  106     1000 FORMAT(1HB,27HINSUFFICIENT RANGE FOR AXIS ,
  107     1/1X,4G./1X,13A5)
  108     CALL EXIT
  109     RETURN
  110     END

  CONSTANTS
  R      175631463146   1      167486111564   2      168517426542   3      '8174631-631   4      000000000003
  S      281483888878   6      174431463146   7      177463146314   18      76463146314   11      000000000002
  12      888888888888   13      175753412172   14      1777E2436568   15      76934121727   16      176782436568
  17      281244838548   28      8888P88888888   21      8888P88888888   22      77907934121   23      175962587584

  GLOBAL DUMMIES
  X0      696           YB      697           AMAX      668           AMIN      661           DELA      662
  AINCH    663           BCD     664           YCR      669           NDEC      666           PHR      667
  DELN    678

  SUBPROGRAMS
  SIGN    IABS    ABS    IFIX    FLOAT    PLOT    EXP3.2    EXP2.2    AMIN1    NUMBER    SYMBOL    WHERE    ALL10C    ALPHOC    ALPHICC
  EXIT

  SCALARS
  AXIS3    673           WT      674           DELX    675           DELA    662           AMAX    668
  AMIN    661           W1      676           -2      677           W3      780           NEXP    781
  NCM     782           NCR    665           PHR     667           CINCH    783           AINCH    663
  NUM     784           ANC    785           X0      656           YB      697           DELN    678
  ANUM    786           X      787           V      710           XM      711           I      712
  II      713           INORE  714           NDEC    666           CENTER  715           OFF     716
  XC      717           YC      720           BST     721           XXC     782           YYC     723
  XQ      724           YQ      725           XXC    726           N      787

  ARRAYS
  BCD    664
  
```


APPENDIX E FMAKE

SHAKE.F4

F48 V27(368)

22-APR-76

11:04

```
1      DIMENSION IDUM(2)
2      DATA IDUM(2)/'1.DAT'
3      COMMON XX,YY,ZZ,TT
4      DIMENSION ILBL(8)
5      DIMENSION X(20),Y(20),Z(20)
6      IMPLICIT COMPLEX (C)
7      DIMENSION C1(20),C2(20),C3(20)
8      COMMON /GROUND/ K,X1(20),Z1(20),X2(0/20),Z2(0/20),IEL
9
10     C THIS SECTION ACCEPTS THE INPUT OF THE SWITCH (ONE CHARACTER) TO
11     C DETERMINE WHAT KIND OF FILE TO GENERATE.
12     C <BLANK> TO END THE PROGRAM
13     C Y      TO SET ANTENNA OFFSET AND XMISSION WAVELENGTH
14     C G      FOR GROUND DESCRIPTION
15     C P      FOR FLIGHT PATH
16     C A      FOR ANTENNA DESCRIPTION
17     WRITE(5,1013)
18     READ(5,1009) NAME
19     IF(NAME .EQ. '') GO TO 3
20     IF(NAME .EQ. 'Y') GO TO 20
21     IF(NAME .EQ. 'G') GO TO 21
22     IF(NAME .EQ. 'P') GO TO 22
23     IF(NAME .EQ. 'A') GO TO 23
24     WRITE(5,1012)
25     GO TO 2
26
27     C THIS IS THE INPUT FOR THE ANTENNA OFFSET AND FOR THE
28     C TRANSMISSION WAVELENGTH, BOTH ARE IN FEET AND ARE FLOATING POINT.
29     C WRITE(5,1011)
30     READ(5,1021) YD,RL
31     GO TO 2
32
33     C THIS SECTION IS FOR GROUND DESCRIPTION
34     C WRITE(5,1014)
35
36     C THIS IS TO INPUT THE FILE NAME FOR GROUND DESCRIPTION
37     C READ(5,105) IDUM(1)
38     C WRITE(5,104)
39
40     C THIS IS TO INPUT THE PLOT LABEL FOR GROUND DESCRIPTION
41     C READ(5,105) ILBL
42     C WRITE(5,100)
43
44     C THIS IS THE INPUT FOR THE GROUND STRIP EDGE COORDINATES
45     C R      DELTA X-COORDINATE FOR CARTESIAN AND
46     C          RANGE FOR POLAR COORDINATES
47     C ZE     DELTA Y-COORDINATE FOR CARTESIAN AND
48     C          USUALLY ZERO FOR POLAR COORDINATES
49     C THETA   ZERO FOR CARTESIAN COORDINATES AND
50     C          THE ELEVATION ANGLE FOR POLAR
51
52     C THIS IS THE INPUT FOR THE STARTING EDGE OF THE FIRST STRIP
53     C READ(5,101,END=2) P,ZZ,THETA
54     C X2(0)=R*COSD(THETA)-ZZ*SIND(THETA)
```

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  94      Z2(0)=R*SIND(THETA)+Z2=COSD(THETA)
  95      K=0
  96      WRITE(5,102)
  97      C
  98      C THIS IS THE INPUT LOOP FOR THE REST OF THE STRIP EDGES. THE
  99      C EDGES ARE THE TRAILING EDGE OF THE PREVIOUS STRIP AND THE
 100      C LEAVING EDGE OF THE NEXT. THE LOOP WILL CONTINUE TO A MAXIMUM OF
 101      C TWENTY STRIPS OR UNTIL BOTH 'R' AND 'Z2' ARE ZERO.
 102      11 READ(5,101,END=2) R,Z2,THETA
 103      IF(R.NE.0.) GO TO 5
 104      IF(Z2.NE.0.) GO TO 5
 105      IF(K.EQ.21) GO TO 2
 106      GO TO 4
 107      5 K=K+1
 108      X1(K)=X2(K-1)
 109      Z1(K)=Z2(K-1)
 110      X2(K)=X2(K-1)+R*COSD(THETA)-Z2=SIND(THETA)
 111      Z2(K)=Z2(K-1)+R*SIND(THETA)+Z2=COSD(THETA)
 112      IF(K.LT.20) GO TO 6
 113      WRITE(5,103)
 114      GO TO 4
 115      6 WRITE(5,102)
 116      GO TO 11
 117      C
 118      C THIS OPENS A FILE FOR THE GROUND DESCRIPTION, OUTPUTS IT
 119      C IN BINARY AND CLOSES THE FILE. FLOW THEN RETURNS TO THE SWITCH POINT.
 120      4 CALL OFILE(20,104)
 121      WRITE(20,105) ILBL
 122      WRITE(20) K,X1,Z1,X2,Z2
 123      CALL RELEASE(20)
 124      GO TO 2
 125      C
 126      C THIS IS THE SECTION TO GENERATE A FLIGHT PATH FILE.
 127      22 WRITE(5,105)
 128      C
 129      C THIS INPUTS THE FLIGT PATH FILE NAME
 130      READ(5,105) IDUM(1)
 131      C
 132      C THIS IS TO CREATE THE FILE IF ONE DOES NOT ALREADY EXIST.
 133      C THIS IS NECESSARY AS JOVRAX DOES NOT CREATE FILES.
 134      CALL OFILE(20,104)
 135      CALL RELEASE(20)
 136      C
 137      C THIS IS TO OPEN THE FILE FOR JOVRAX
 138      CALL JOVSET(1,104,NSIZE)
 139      WRITE(5,106)
 140      C
 141      C THIS IS TO INPUT THE FLIGHT PATH PLOT LABEL AND OUTPUT IT TO
 142      C THE FILE
 143
 144      READ(5,106) ILBL
 145      CALL JOVHO(1,ILABL,8,8)
 146      WRITE(5,106)

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EMANUE	F48	V27(368)	22-APR-76	11184
187	C			
188	C THIS SWITCH IS TO SELECT EITHER STRAIGHT LINE FLIGHT OR			
189	C HYPERBOLIC. 'G' INPUT WILL SELECT HYPERBOLIC ANYTHING ELSE WILL			
190	C GIVE STRAIGHT LINE.			
191	READ(5,1800) I			
192	IF(I .NE. 'G') GO TO 12			
193	C			
194	C THIS IS THE HYPERBOLIC FLIGT SECTION			
195	WRITE(5,1810)			
196	C			
197	C THIS IS THE INPUT TO DESCRIBE THE FLIGHT			
198	X0 STARTING X-COORDINATE			
199	XF ENDING X-COORDINATE			
200	H HEIGHT OF MAIN ELEMENT USED TO DETERMINE GLIDE ANGLE			
201	AND HEIGHT ABOVE GROUND OF ZERO COI SURFACE AT CLOSEST			
202	APPROACH			
203	READ(5,1811) X0,XF,H			
204	WRITE(5,1806)			
205	C			
206	C THIS INPUT IS FOR THE FLIGHT PATH QUANTIZATION PARAMETERS			
207	NK IS THE NUMBER OF POINTS ALONG THE FLIGHT PATH			
208	V IS THE VELOCITY (FT./SEC.) OF THE AIRCRAFT			
209	TAU IS THE TIME CONSTANT (SEC.) FOR THE DYNAMIC COI			
210	READ(5,1807) NK,V,TAU			
211	IF(NK .LE. 0) GO TO 22			
212	CALL JOVW0(1,TAU,1,0)			
213	C			
214	C THIS LOOP GENERATES THE COORDINATES OF THE POINTS ALONG THE			
215	C HYPERBOLA AND OUTPUTS THEM TO THE FLIGHT PATH FILE			
216	A1=RL*25-H*H-Y0*Y0			
217	A2=1./((1.-4.*H*H/RL)/RL)			
218	DX=(XF-X0)/FLOAT(NK-1)			
219	XX=X0			
220	YY=0.			
221	TT=0.			
222	X0L=XX			
223	Z0L=SQRT((A1-XX*XX)*A2)			
224	DO 13 I=1,NK			
225	Z2=SQRT((A1-XX*XX)*A2)			
226	TEMP=XX-X0L			
227	TEMP2=Z2-Z0L			
228	TT=TT+SQRT(TEMP*TEMP+TEMP2*TEMP2)/V			
229	CALL JOVW0(1,XX,4,P)			
230	X0L=XX			
231	Z0L=Z2			
232	XX=XX+DX			
233	CONTINUE			
234	GO TO 14			
235	C			
236	C THIS SECTION IS FOR STRAIGHT LINE FLIGHT			
237	CONTINUE			
238	WRITE(5,1804)			
239	C			

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168      C THESE INPUTS ARE TO DESCRIBE THE FLIGHT PATH
161      C XX  STARTING X-COORDINATE (FEET)
162      C YY  STARTING Y-COORDINATE (FEET)
163      C ZZ  STARTING Z-COORDINATE (FEET)
164      C XF  ENDING X-COORDINATE (FEET)
165      C YF  ENDING Y-COORDINATE (FEET)
166      C ZF  ENDING Z-COORDINATE
167      C NK  NUMBER OF POINTS ALONG THE FLIGHT PATH
168      C V   VELOCITY OF AIRCRAFT (FEET/SEC.)
169      C TAU TIME CONSTANT FOR DYNAMIC COI (SEC)
170      C READ(5,101) XX,YY,ZZ
171      C WRITE(5,1005)
172      C READ(5,101) XF,YF,ZF
173      C WRITE(5,1006)
174      C READ(5,1007) NK,V,TAU
175      C IF( NK .LE. 0 ) GO TO 22
176      C CALL JOVHO(1,TAU,1,0)
177      C FN=NK-1
178      C DX=(XF-XX)/FN
179      C DY=(YF-YY)/FN
180      C DZ=(ZF-ZZ)/FN
181      C DT=SQRT(DX*DX+DY*DY+DZ*DZ)/V
182      C TT=0.
183      C
184      C      LOOP TO GENERATE X-,Y-, AND Z-COORDINATES AND OUTPUT THEM
185      C TO THE FLIGHT PATH FILE
186      C DO 1 I=1,NK
187      C CALL JOVHO(1,XX,4,0)
188      C XX=XX+DX
189      C YY=YY+DY
190      C ZZ=ZZ+DZ
191      C TT=TT+DT
192      C
193      C      THIS CLOSES THE FLIGHT PATH FILE AND RETURNS TO SWITCH POINT
194      C CALL JOVREL(1)
195      C GO TO 2
196      C
197      C      THIS SECTION IS TO GENERATE ANTENNA DESCRIPTION FILE
198      C N=0
199      C WRITE(5,107)
200      C
201      C      INPUT FOR ANTENNA FILE NAME
202      C READ(5,2000) ILBL
203      C WRITE(5,108)
204      C
205      C      INPUT FOR ANTENNA PLOT LABEL
206      C READ(5,105) ILABL
207      C N=1
208      C
209      C      THIS IS THE INPUT FOR ELEMENT DESCRIPTION
210      C X(I)  X-COORDINATE OF I'TH ELEMENT (FEET)
211      C Z(I)  Z-COORDINATE OF I'TH ELEMENT (FEET)
212      C C1(I) COMPLEX AMPLITUDE OF CARRIER COMPONENT OF I'TH ELEMENT
  
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213      C      C2(I)  COMPLEX AMPLITUDE OF 150 Hz SIDEBAND OF I'TH ELEMENT
214      C      C3(I)  COMPLEX AMPLITUDE OF 90 Hz SIDEBAND OF I'TH ELEMENT
215      C THE PROGRAM WILL LOOP THRU 10 FOR ADDITIONAL ELEMENTS UNTIL A
216      C      ZERO IS ENCOUNTERED FOR Z(N)
217      C      WRITE(5,1017)
218  10     READ(5,2001) X(N),Z(N),C1(N),C2(N),C3(N)
219      IF( Z(N) .EQ. 0 ) GO TO 9
220      C
221      C      THIS SECTION DETERMINES THE Y OFFSET OF EACH ELEMENT. THIS
222      C IS NOMINALLY Y0 BUT THERE IS A SMALL CHANGE (LESS THAN ONE WAVELENGTH)
223      C FOR NEAR FIELD CORRECTION PURPOSES
224      SH=SIGN(1.,Z(N)-Z(1))
225      IF(N .NE. 1) GO TO 15
226      Y(1)=Y0
227      F=SQRT(Y0+Y0+Z(1)*Z(1))
228      GO TO 16
229  15     XB=Y0-SQRT(F+F-Z(N)*Z(N))
230      IF(XB>SH .LT. E) GO TO 17
231  19     XP=Y0-SQRT((F+RL)*(F+RL)-Z(N)*Z(N))
232      IF(XP>SH .LT. E) GO TO 18
233      F=F+RL*SH
234      XB=XP
235      GO TO 19
236  17     F=F-RL*SH
237      GO TO 15
238  18     Y(N)=Y0-XB
239  16     CONTINUE
240      N=N+1
241      GO TO 18
242      C
243      C      THIS SECTION OUTPUTS THE ANTENNA DESCRIPTION TO THE FILE
244      C AND ON THE LINE PRINTER. CLOSES THE FILE AND RETURNS TO THE SWITCH
245      C POINT
246  9      NEL=N-1
247      CALL OFILE(20,ILBL)
248      WRITE(20,105) ILBL
249      WRITE(20) RL,NEL,(X(I),Y(I),Z(I),C1(I),C2(I),C3(I),I=1,NEL)
250      WRITE(3,1016) ILBL
251      WRITE(3,2001) (X(I),Y(I),Z(I),C1(I),C2(I),C3(I),I=1,NEL)
252      CALL RELEASE(20)
253      GO TO 2
254      C
255      C      THIS IS THE PROGRAM TERMINATION POINT
256  3      CALL EXIT
257      STOP
258  1012  FORMAT('UNKNOWN SWITCH.')
259  1013  FORMAT(' INPUT SWITCH:',$)
260  1014  FORMAT(' INPUT GROUND FILE NAME:',$)
261  1015  FORMAT(' INPUT FLIGHT PATH FILE NAME:',$)
262  1017  FORMAT(' INPUT ELEMENT VALUES..',/)
263  1016  FORMAT(2X,B45)
264  104   FORMAT(' INPUT GROUND LABEL',/)
265  105   FORMAT(B45)
  
```

FRAME,F4 F48 V27(368) 22-APR-76 11:04
 206 100 FORMAT(' INPUT GROUND SEGMENTS. STARTING FROM ANTENNA. ','/
 207 ' GIVE CONSECUTIVELY EITHER X AND Z INCREMENTS, OR THE ','/
 208 ' LENGTH AND ANGLE FROM HORIZONTAL IN DEGREES, SEPARATED ','/
 209 ' BY A ZERO. HIT CARRIAGE RETURN FOR END OF DATA. ','/
 210 ' OR IF THERE ARE NO MORE STRIPS. ','/
 211 ')
 212 101 FORMAT(1P)
 213 103 FORMAT(' ONLY 20 GROUND SEGMENTS ALLOWED. COMPUTATION WILL ','/
 214 ' PROCEED WITH DATA ALREADY OBTAINED. ','/
 215)
 216 102 FORMAT(1E,1S)
 217 1003 FORMAT(' INPUT FLIGHT PATH TITLE ','/
 218 1000 FORMAT(' INPUT FLIGHT PATH TYPE ','/
 219 1000 FORMAT(1A)
 220 1010 FORMAT(' INPUT XP,XF,WL ',1S)
 221 1011 FORMAT(' INPUT YB,LAMBDA ',1S)
 222 1004 FORMAT(' INPUT X0,Y0,Z0T ',1S)
 223 1009 FORMAT(' INPUT XP,YF,EP ',1S)
 224 1006 FORMAT(' INPUT # OF POINTS, VELOCITY, TIME CONSTANT ',1S)
 225 1007 FORMAT(1.2F)
 226 107 FORMAT(' INPUT ANTENNA FILE NAME ','/
 227 2000 FORMAT(A5)
 228 108 FORMAT(' INPUT ANTENNA DESCRIPTION ','/
 229 2001 FORMAT(9F)
 230 ENR

 CONSTANTS
 P 201004020100 1 949004020100 2 439004020100 3 501004020100 4 403004020100
 3 000000000000 6 000000000001 7 200000000000 10 000000000000 11 000000000000
 12 201004020100 9

 COMMON
 XX /.COMM./+0 YY /.COMM./+1 ZZ /.COMM./+2 TT /.COMM./+3 R /.COMM./+4
 X1 /GROUND/+1 Z1 /GROUND/+25 ZZ /GROUND/+51 TT /GROUND/+76 IEL /GROUND/+0
 /GROUND/+123

 SUBPROGRAMS
 FORSE, JUFF END, COSD, SIND, OFILE, BINWR, RELEASE, JOVSET, JOVHO, FLOAT, SORT, JOVREL, SIGN, EXIT
 ALPHA, ALPHI, FLAUT, FLIRT, INTO, INTI,

 SCALARS
 NAME 1410 Y0 1411 ZL 1412 R 1413 Z2 S
 THETA 1414 X 9 1415 1416 1417 X0
 XF 1420 M 1421 V 1422 1423 TAU
 A1 1425 42 1426 2X 1427 XX 0 YY
 TT 3 XOL 1432 ZOL 1431 TEMP 1430 TEMP2 1433
 YF 1430 2F 1435 FN 1436 DY 1437 DR 1448
 DT 1441 N 1442 TBL 1443 SW 1444 F 1449
 XP 1446 NEL 1447 IEL 123

 ARRAYS

NAME, F4	F46	V27(368)	22-APR-76	11184								
	JOHN	1450		ILABL	1452	X	1462	V	1980	E	1932	
	C1	1554		C2	1526	C3	1676	X1	1	S1	S2	
	S2	S1		S2	S1							
A1	156	143	145									
A2	157	143	145									
C1	7	218	249	251								
C2	7	218	249	251								
C3	7	218	249	251								
COS0	53	54	70	71								
DT	101	191										
DX	130	152	178	181	188							
DY	172	181	189									
DR	100	101	190									
EXIT	250											
F	227	229	231	233	236							
FLOAT	130											
FN	177	178	179	180								
GROWD	0											
H	123	136	137									
I	111	112	144	186	249	251						
JOHN	1	2	37	88	98	94	98					
IEL	0											
ILBL	282	247										
JOVREL	194											
JOVRET	98											
JOVWQ	195	132	149	176	187	69	78	71	72	82	240	246
K	0	55	65	67	68	224	225	229	231	238		
N	178	287	210	219	224							
NAME	18	19	20	21	22	23						
NCL	246	249	251									
NN	130	131	138	144	174	175	177	180				
NSIZE	98											
OFILE	98	94	247									
R	92	53	54	62	63	78	78	71				
RELEASE	85	95	292									
RL	30	136	137	231	233	236	249					
SIGN	224											
SIND	93	54	78	71								
SORT	143	145	168	181	227	229	231					
SW	224	238	232	233	236							
TAIL	138	132	174	176								
TEMP	146	148										
TEMPR	147	148										
THETA	92	53	54	62	78	71						
TT	3	141	148	182	193							
V	138	140	174	181								
X	3	218	249	251								
Y	123	130	139	229	238	234	238					
Z1	0	40	62									
Z2	0	53	48	78	82							
ZF	123	130	172	178								
ZOL	142	146	150									
ZP	221	232	234									
XX	3	139	142	143	145	146	149	198	192	178	170	167
YY	3	226	238	249	251							

Y6	38	136	226	227	229	230	230
YF	172	179					
YY	3	142	178	179	189		
Z	2	216	19	224	227	229	231
Z1	8	69	62				
Z2	8	54	69	71	62		
ZF	172	187					
ZG	20	143	147	151			
ZS	3	52	93	94	62	64	78
						71	145
1P	186	191					147
2P	17	25					191
3P	19	255					178
4P	66	74					100
5P	63	64					198
6P	72	75					
9P	219	246					
15P	218	241					
11P	92	76					
12P	112	157					
13P	144	153					
14P	154	194					
15P	225	229	257				
16P	228	239					
17P	238	236					
18P	232	238					
19P	231	235					
20P	29	29					
21P	21	34					
22P	22	87	171	175			
23P	23	198					
168P	42	266					
181P	38	52	62	123	78	172	271
182P	56	75	274				
183P	73	272					
184P	38	264					
185P	37	41	81	98	184	286	248
187P	199	284					
188P	283	286					
1883P	99	275					
1884P	198	208					
1885P	171	241					
1886P	124	171	27				
1887P	138	174	27				
1888P	186	276					
1889P	18	111	277				
1818P	119	376					
1811P	29	179					
1812P	24	258					
1813P	17	259					
1814P	34	267					
1815P	67	271					
1816P	298	26					
1817P	217	262					
2880P	282	285					
2881P	310	251	28				